United States Department of Energy

Nuclear Criticality Safety Program

Five-Year Execution Plan for the Mission and Vision

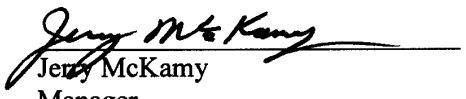
FY 2009 through FY 2013

National Nuclear Security Administration

September 2008

Nuclear Criticality Safety Program Five-Year Execution Plan, for Fiscal Years 2009-2013, September 2008.

Approved:



Jerry McKamy
Manager
Nuclear Criticality Safety Program

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ACRONYMS AND DEFINITIONS

AM	Analytical Methods
AMPX	Nuclear Cross-Section Processing Computer Code Developed by ORNL
ANL	Argonne National Laboratory
ANS	American Nuclear Society
ARH-600	Atlantic Richfield Hanford
BNL	Brookhaven National Laboratory
CEA	Commissariat à l'Énergie Atomique
C_edT	Critical-Subcritical Experiment Design Team
CE-KENO	Continuous Energy Version of the KENO Code
CEF	Criticality Experiments Facility
CENTRM	Continuous-Energy Transport Module Within the SCALE Code System
CFD	Computational Fluid Dynamics
COG [1]	Lawrence Livermore National Laboratory Monte Carlo Computer Code
COMBINE	Idaho National Laboratory Cell Code
CSCT	Criticality Safety Coordinating Team
CSEWG	Cross-Section Evaluation Working Group
CSSG	Criticality Safety Support Group
DAF	Device Assembly Facility
DICE	Database for the International Criticality Safety Benchmark Evaluation Project
DOE	United States Department of Energy
EDA	Energy Dependent Analysis
EMPIRE	BNL Nuclear Reaction Model Code System for Data Evaluation
ENDF	Evaluated Nuclear Data File
EUG	End-Users Group
FY	Fiscal Year
GNASH[3]	A Statistical Nuclear Model Computer Code
GODIVA	Fast-Burst Reactor
GUI	Graphical User Interface
HEU	Highly-Enriched Uranium
IAEA	International Atomic Energy Agency

ICSBEP	International Criticality Safety Benchmark Evaluation Project
IE	Integral Experiments
INL	Idaho National Laboratory
IP&D	Information Preservation and Dissemination
IRMM	Institute for Reference Materials and Measurements
IRSN	Institut De Radioprotection et De Sûreté Nucléaire
JEFF	Joint Evaluated Fission and Fusion File
JENDL	Japanese Evaluated Nuclear Data Library
KALMAN	Bayesian Code that Estimates Covariances
k_{eff}	The mean number of fission neutrons produced by a neutron during its life within the system
KENO[4]	Monte Carlo Criticality Computer Code
LANL	Los Alamos National Laboratory
LANSCE	Los Alamos Neutron Science Center
LLNL	Lawrence Livermore National Laboratory
McGNASH	A modern version of the GNASH code developed at LANL to produce nuclear data evaluation files for the ENDF
MCNP	Monte Carlo N Particle (N currently equals 3) Computer Code
MIRTE	Matériaux Interaction Réflexion Toutes Epaisseurs
NA-17	Assistant Deputy Administrator for Facility and Infrastructure Acquisition and Operation
NCS	Nuclear Criticality Safety
NCSET	Nuclear Criticality Safety Engineer Training
NCSP	Nuclear Criticality Safety Program
ND	Nuclear Data
NDAG	Nuclear Data Advisory Group
NNSA	National Nuclear Security Administration
OECD/NEA	Organization for Economic Cooperation and Development/Nuclear Energy Agency
ORELA	Oak Ridge Electron Linear Accelerator
ORNL	Oak Ridge National Laboratory
RPI	Renssalaer Polytechnic Institute
PUFF	Multigroup Covariance Processing Code for the AMPX Cross-Section
RSICC	Radiation Safety Information Computational Center
SAMMY[5]	A Nuclear Model Computer Code

SCALE[6]	Standardized Computer Analyses for Licensing Evaluation
SILÈNE	Commissariat à l'Énergie Atomique Uranium Solution Critical Assembly
SNL	Sandia National Laboratories
SNM	Special Nuclear Materials
SQA	Software Quality Assurance
SRNL	Savannah River National Laboratory
S/U	Sensitivity/Unsensitivity
TRACY	Japan Atomic Energy Agency's (JAEA) – Transient Experiment Critical Facility
TSUNAMI	Tool for Sensitivity and Uncertainty Analysis Methodology Implementation
TSURFER[7]	Tool for Sensitive and Uncertainty Analysis of Response Functionals Using Experimental Results
T&E	Training and Education
URR	Unresolved Resonance Region
U.S.	United States
USLSTATS	Computer Program for Statistics
V&V	Verification and Validation
VIBE	Validation Interpretation and Bias Estimation
VIM	Vastly-Improved Monte Carlo Computer Code
VIMB	VIM Cross-Section Library Processing System
WINCO	Westinghouse Idaho Nuclear Company
WNR	Weapons Neutron Research Facility
WPEC	Working Party on International Evaluation Cooperation
ZPR	Zero-Power Reactor

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[1]COG was originally developed to solve deep penetration problems in support of underground nuclear testing. Variance reduction techniques are very important to these problems and hence the name COG was chosen as in "to cog the dice" or cheat by weighting.

[2]EVENT is a Pn solver for the neutron transport equation. It is maintained (and was written) by Professor Cassiano de Oliveira. Professor Oliveira has a joint appointment with the Nuclear Engineering Department at the University of New Mexico and at the Idaho National Laboratory (INL).

[3]GNASH is a pre-equilibrium, statistical nuclear model code based on Hauser-Feshbach theory (and additional models) for the calculation of cross sections and emission spectra, primarily in the epithermal and fast neutron energy ranges.

[4]KENO is a family of Monte Carlo criticality codes whose name came from an observation of the KENO game in which small spheres, under air levitation, arbitrarily move about in a fixed geometry.

[5]SAMMY is a nuclear model code, which applies R-Matrix theory to measured data and produces resolved and un-resolved resonance parameters in Reich-Moore and other formalisms.

[6]SCALE is a system of well-established codes and data for performing nuclear safety (criticality, shielding, reactor physics and fuel irradiation) analyses.

[7]TSURFER is a prototype module of the SCALE code system that performs a generalized linear least squares adjustment of cross-section data to produce consistency between calculated and experimental results. When coupled with TSUNAMI sensitivity data for a criticality safety application, the adjusted cross-section data can be used to predict a computational bias and its uncertainty.

United States Department of Energy
Nuclear Criticality Safety Program
Five-Year Execution Plan

1.0 Nuclear Criticality Safety Program Mission and Vision

The Nuclear Criticality Safety Program (NCSP) Mission and Vision (MV), as stated in *The Mission and Vision of the United States Department of Energy Nuclear Criticality Safety Program for the Fiscal Years 2009-2018* (http://ncsp.llnl.gov/NCSP-MV-COMPRESSED.pdf), are:

> The NCSP mission is to provide **sustainable expert** leadership, direction, and the technical infrastructure necessary to develop, maintain, and disseminate the essential technical tools, training, and data required to support **safe, efficient** fissionable material **operations** within the United States (U.S.) Department of Energy (DOE).
>
> The NCSP will be a **continually improving, adaptable,** and **transparent** program that **communicates** and **collaborates** globally to incorporate technology, practices, and programs to be **responsive** to the essential technical needs of those responsible for developing, implementing, and maintaining nuclear criticality safety.

The NCSP is funded by the National Nuclear Security Administration (NNSA). Dr. Jerry McKamy from NA-17 is the NCSP Manager. He is supported by the Criticality Safety Support Group (CSSG) and the Nuclear Data Advisory Group (NDAG) regarding technical matters and by the Criticality Safety Coordinating Team (CSCT), consisting of Federal Criticality Safety Practitioners at the sites, and the End-Users Group (EUG) consisting of contractor criticality safety representatives at the sites regarding DOE field criticality safety issues. Charters for each of these groups can be found on the NCSP website at: (http://ncsp.llnl.gov/).

2.0 Technical Program Elements

The NCSP includes the following six technical program elements:

- Analytical Methods
- Information Preservation and Dissemination
- Integral Experiments
- International Criticality Safety Benchmark Evaluation Project
- Nuclear Data
- Training and Education

A description of how each of these elements contributes to the enhancement of criticality safety is contained in the NCSP MV document. This Five-Year Execution Plan contains the road map for each of the six technical program elements, including a budget, subtasks, and milestones for completing the work and achieving the NCSP Vision. All subtasks are approved based on their

contribution to the achievement of the five- and ten-year goals in the MV document. A budget summary for the NCSP is contained in Table 2-1.

Table 2-1. Nuclear Criticality Safety Program Funding
Fiscal Years (FY) 2009 – 2013

FY 2009 ($K)	FY 2010 ($K)	FY 2011 ($K)	FY 2012 ($K)	FY 2013 ($K)
$12,800	$15,062	$15,853	$15,771	$16,059

Finally, the goal of the NCSP is to provide "transparent responsiveness" for the DOE and Stakeholders. Therefore, this Plan and all accomplishments achieved under the auspices of the NCSP are posted in a timely manner on the NCSP website at: http://ncsp.llnl.gov/.

2.1 Analytical Methods

2.1.1 Program Element Description

The Analytical Methods (AM) program element provides for the development and maintenance of state-of-the-art analytical capability for the processing of nuclear data from the Evaluated Nuclear Data File (ENDF) and the radiation transport analysis needed to support nuclear criticality safety evaluations for subcriticality and shielding. An essential aspect of this capability is the human expertise required to develop the analytical software, provide software configuration control, and train and assist the user community. Additional information about the AM vision and strategy can be found in the *Mission and Vision of the U.S. Department of Energy, Nuclear Criticality Safety Program*, March 2008 document. A funding table is provided at the end of this program element section.

2.1.2 Approved Subtasks (FY 2009 through FY 2013)

ANL AM SUBTASKS

FY 2009

ANL AM Subtask 1 ($420K)
Support and Development of Advanced Methods: Resonance theory, advanced covariance theory and methods, code/library Verification and Validation (V&V), chair the Organization for Economic Cooperation and Development/Nuclear Energy Agency (OECD/NEA) expert group on source convergence, participates in the OECD/NEA Working Party on Nuclear Criticality Safety (WPNCS) expert groups on Assay Data for Spent Nuclear Fuel and Uncertainty Analysis for Criticality Safety Assessment, and user support.

Milestones:

- Methods will be implemented and tested, reported to the Cross-Section Evaluation Working Group (CSEWG) and the NDAG Chair, and reported in NCSP Quarterly Progress Reports. (Q1, Q2, Q3, Q4).
- Provide interim communications with Los Alamos National Laboratory (LANL) and Oak Ridge National Laboratory (ORNL) staff and report Vastly Improved Monte Carlo Computer Code (VIM) Cross-Section Library Processing System (VIMB) library improvements in NCSP Quarterly Progress Reports (Q1, Q2, Q3, Q4).
- Notify the NCSP Manager about new OECD/NEA source convergence reports so the NCSP Website can link to them (quarter when they are published).
- Release new code versions to the Radiation Safety Information Computational Center (RSICC) (Q4).

ANL AM Subtask 2 ($100K)

VIMB Library Processing Methodology: Processing and testing of β versions of ENDF/B-VII.1 libraries are ongoing.

Milestone:

- Release a current data ENDF/B-VII library to RSICC (Q4).

ANL AM Subtask 3 ($10K)

Provides support for Doug Muir as an Argonne National Laboratory (ANL) Special-Term Appointee for development of advanced covariance data and methodologies (e.g., material-to-material covariance data, application of Global Assessment of Nuclear Data Requirements to assess nuclear data requirements, etc.).

Milestone:

- Report contributions to the NDAG Chair. A summary of contributions will be included in NCSP Quarterly Progress Reports (Q2, Q4).

ANL FY 2010 through FY 2013

For Subtasks 1, 2, and 3, FY 2010 through FY 2013, the description/scope and milestones are the same as FY 2009.

INL AM SUBTASKS

The INL has proposed to develop a rigorous fully coupled, multi-dimensional Computational Fluid Dynamics (CFD) / neutron transport capability for accidental reactivity excursions in metal systems, as an initial development step leading to a longer-term capability to model accidental excursions in tanks containing solutions of fissile materials. The result of this effort will be a modern state-of-the-art excursion analysis capability within the US that moves past the shortcomings of current methods in both physical modeling and numerical algorithms. The excursion analysis tool will be based on modern V&V plus uncertainty quantification methods.

The INL will utilize modern, tested,

- Time-accurate multiphysics coupling algorithms that have previously been used to couple two-phase-flow, heat conduction and reactor kinetics, and thermally driven flows with phase change
- Time and space accurate CFD
- Fully coupled approaches to computing cross-sections consistent with the evolving temperature, concentration, and density fields
- Transport methods
- Parallel linear and nonlinear solver methods.

This excursion analysis tool will be executable in a parallel computing environment, allowing for large scale application. However, it will also be executable on a modern desktop computing environment.

The focus of this task is the multiphysics simulation of fissile solutions; however, the methodology is applicable to simulation of accidental criticality with metals. The initial phases of this task will therefore concentrate on conducting a proof of principle demonstration based on the GODIVA-IV metallic assembly, and on initiation of efforts for low-power solution transients. This will largely be done during the first 2-3 years, and the work scope will then evolve toward high-power solution transients and additional development of the methodology for metal systems in years 3-5. In the solution transients, a simpler single-phase fluids model will apply. This will allow the development of the multiphysics framework, coupled to transport and inline cross-section computations, within the context of a simpler fluid model. Validation efforts for the solution transients will draw from previously published results and from data from TRACY and SILENE experiments.

FY 2009

INL AM Subtask 1 ($100K)

Perform a rudimentary multiphysics simulation of the GODIVA-IV prompt burst, initially using 1-D spherical metal systems. The next step will involve the GODIVA-IV in a 2-D r-z geometry with a hydrodynamic model for the metal. Initial proof of principle efforts in FY 2009 will utilize COMBINE in a stand-alone mode for generation of cross-section fitting tables for the GODIVA-IV experiment as functions of the pertinent variables, validated against the static critical. The 2-D capability will be used to simulate prompt burst phenomena with feedback from metal thermal expansion and transport effects.

Milestone:

- Provide a report describing the equation system, time and space discretization, solution methodology, and results from verification tests to the NCSP manager and submit a paper to a peer reviewed technical journal (Q4).

FY 2010

INL AM Subtask 1

A modern, multi-dimensional, Finite Element Method flow solver will be developed, starting with a modern nonlinear / linear solver library with existing preconditioners, finite element discretization templates, and the incompressible Navier-Stokes equations with Boussinesq approximation for density driven flow. Available properties for uranyl nitrate, plutonium nitrate, and mixed uranium/plutonium nitrate solutions will be included. A fully implicit Jacobian-free Newton-Krylov solver, and a classical projection method as a preconditioner will be used. This approach has been demonstrated numerous times and has been shown to be both more accurate and more efficient than the computational fluid dynamics methods used in the FETCH code and should make the extension to multiphase flow straightforward. A verification study of time and space convergence will be executed for this problem component of the multiphysics simulation tool using the classic thermally driven cavity problem, both steady-state and transient.

Milestone:

- Provide a report documenting the equation system, time and space discretization, solution methodology, and results from the verification tests (Q4).

INL AM Subtask 2

Modeling of the time evolution of cross sections to account for local spectral effects and fluid properties: Computation of time-dependent multigroup cross sections for neutronics modeling will be accomplished using well-established methods, modified to reflect local spectral variations caused by spatially non-uniform variations in temperature and density of the fissile fluid or metal during a transient. The COMBINE cell spectrum and cross-section generation code, recently updated to use ENDF/B-VII cross-section input libraries, will serve as the basis for an online cross-section generation module in the multiphysics framework. Full online coupling of the COMBINE model to account for local spectral variations during the transient will be initiated.

Verification and validation of this approach to modeling of local cross-section variations due to the nonuniformities in the fluid will be accomplished by separate static simulations of evaluated critical solution and metal experiments using one- and two-dimensional discrete ordinates codes for the global neutronics calculation, coupled to the COMBINE-based cross-section model for cross-section generation. The results of these simulations, with and without nonuniformities in fluid properties, will be compared to independent full three-dimensional, continuous-energy calculations for the same models performed using the Monte Carlo N Particle computer code (MCNP5). This will allow a quantification of the accuracy of the buckling approximation used in COMBINE to represent the local effects of non-uniform fluid temperature and density on the cross sections.

Milestone:

- Provide a report documenting the development of the tailored cross-section module for the multiphysics framework from the base COMBINE code. The report will include V&V of the methods and models (Q4).

INL AM Subtask 3

Application of modern multiphysics coupling methods to a 2-D problem of nonlinear space dependent kinetics (with transport): a 2-D "no flow" simulation will be used to model the problem. This task will initially rely on the use of the Even Parity Transport (EVENT) transport software. As the overall project moves forward, some new software may be developed for the neutronics and some existing software from EVENT may be brought inside the multiphysics simulation framework. A verification study for time accuracy of multiphysics coupling will be conducted.

Milestone:

- Provide a report describing the equation system, time and space discretization, solution methodology, and results from the verification tests (Q4).

FY 2011

INL AM Subtask 1

Advection of delayed neutron precursor concentrations: A module will be written which advances these concentrations with a given 2-D fluid velocity profile. An initial test of this capability will add a "fixed" 2-D velocity field (a vortex) to the results of previous work. This will be allowed to impact both the temperature field and the delayed neutron precursor concentrations. A verification of spatial and time accuracy will also be done.

Milestone:

- Provide a report describing the equation system, time and space discretization, solution methodology, and results from the verification tests (Q4).

INL AM Subtask 2

Assemble components from previous work into a final multiphysics simulation framework. This task will provide a comprehensive simulation tool for lower power transients in which radiolytic gas bubbles are not consequential. This multiphysics simulation will have less numerical truncation error, more self-consistent cross-sections, a modern multiphysics coupling approach, and the ability to efficiently use transport in place of diffusion.

Milestone:

- Provide a report documenting the first multiphysics simulation of the low-power transient (Q4).

INL AM Subtask 3

Validation on low-power transient ignoring gas impacts: A validation study, attempting to match both power traces and spatially dependant thermocouple traces from a specific low-power transient in TRACY, will be conducted. This multiphysics simulation capability will be the most rigorous attempt, to date, at matching measured temperature traces at various spatial locations. Some limited sensitivity studies on the capabilities of the tool, with a focus on those capabilities which are new compared to FETCH, will be performed.

Milestone:

- Provide a report documenting the first validation effort with the new multiphysics simulation capability and a beta-test version of the simulation tool (Q4).

FY 2012

INL AM Subtask 1

Advance fluids physics model and required solver updates: The fluid physics model will primarily involve moving to a two-phase system to model the impacts of radiolytic gas bubbles and also to include some compressibility effects. A free-surface flow method for simulating fluid sloshing will also be included.

Milestone:

- Provide a report documenting the advanced fluid physics model (Q4).

INL AM Subtask 2

Incorporate Sensitivity/Uncertainty (S/U) quantification methods: In this task some forward sensitivity analysis capability will be put into the simulation tool to allow users to better understand the sensitivities of a few select parameters without manually making several runs and changing parameters.

Milestone:

- Provide a report documenting S/U incorporation into the model (Q4).

FY 2013

INL AM Subtask 1

Detailed validation: A detailed validation study will be undertaken which includes high-power transients on the TRACY and SILÈNE experiments. Again, this simulation tool will be able to study both power traces and detailed time traces of temperature at various spatial locations. This validation will also include simulations of 1-D metal systems.

Milestone:

- Provide a report documenting the validation study (Q4).

INL AM Subtask 2

User manual/documentation.

Milestone:

- Publish a users manual (Q4).

LANL AM SUBTASKS

FY 2009

LANL AM Subtask 1 ($600K)

This task provides ongoing maintenance of the basic capabilities for performing Nuclear Criticality Safety (NCS) calculations with MCNP5 and MCNP6 and includes user support, support for improved nuclear data, V&V, general code maintenance, and transition from MCNP5 to MCNP6.

Milestones:

- Issue V&V report supporting transition from MCNP5 to MCNP6 (Q2).
- Implement new continuous S(α,β) treatment in MCNP (Q3).
- Issue V&V report on new S(α,β) treatment (Q4).
- Issue report on MCNP testing on latest computer platforms (Q3).
- Release of updated MCNP5 to RSICC (Q4).

LANL AM Subtask 2 ($125K)

Develop, document, and release quality-assured MCNP nuclear data libraries.

Milestones:

- Release quality-assured MCNP neutron cross-section library for priority NCSP isotopes based on ENDF/B-VII.1.beta, Joint Evaluated Fission and Fusion File (JEFF) section processing system, and Japanese Evaluated Nuclear Data Library Japanese Evaluated Nuclear Data Library (JENDL) evaluations (Q4).
- Issue a report on the new MCNP library (Q4).

LANL AM Subtask 3 ($150K)

Develop and maintain the Neutron Cross-Section Processing Code (NJOY) nuclear data processing code system. Implement revised capabilities as needed to process new and evolving covariance formats defined by the newly formed CSEWG Covariance Committee and by the NEA Working Party for Evaluation Cooperation, Working Party on International Evaluation Cooperation (WPEC-28) (processing of covariance data). Base versions of the NJOY code system will continue to be distributed to the domestic user community through RSICC and to the international user community through the NEA with code updates distributed to all users through a LANL maintained website.

Milestone:

- Release NJOY code updates required to process new and evolving covariance formats to RSICC (Q4).

LANL AM Subtask 4 ($150K)

Develop and demonstrate S/U capabilities with MCNP. The first phase will demonstrate that MCNP can be used reliably to generate cross-section sensitivity profiles for applications of interest to the NCSP.

Milestones:

- Demonstrate that MCNP5 can be used to generate sensitivity profiles for nuclear data, by analyzing configurations and datasets relevant to NCSP (Q4).
- Compare MCNP5 sensitivity profile results with comparable results from Tool for Sensitivity and Uncertainty Analysis Methodology Implementation (TSUNAMI) (Q4).
- Issue report on results (Q4).

LANL AM Subtask 5 ($125K)

This task provides for the development of new, more powerful, and more flexible state-of-the-art capabilities for performing NCS calculations with MCNP. These capabilities provide improved methods for determining source convergence, preventing false convergence, accelerating convergence, eliminating bias in confidence intervals, and implementing a radically new method for importance (adjoint) calculations and reactivity worth in the outyears.

Milestones:

- Release to RSICC a production version of MCNP5 that includes the Wielandt method for accelerating convergence, including V&V and documentation (Q1).
- Issue a report and documentation of confidence interval bias elimination in MCNP (Q3).
- Make presentations to OECD/NEA Expert Group on Source Convergence and to Nuclear Criticality Safety (NCS) users at an American Nuclear Society (ANS) meeting (Q4).

FY 2010 through FY 2013

LANL AM Subtask 1

The scope/description is the same as FY 2009.

Milestones:

- Issue a report on MCNP testing on the latest computer platforms (Q3).
- Issue a V&V report (Q2, Q4).
- Release an updated version of MCNP5 to RSICC (FY 2010, Q4).
- Release the initial version of MCNP6 to RSICC (FY 2011, Q4).
- Release an updated version of MCNP6 to RSICC (FY 2012 and FY 2013, Q4).

LANL AM Subtask 2

The scope/description and milestones are the same as FY 2009.

FY 2010

LANL AM Subtask 3

The scope for this task is the same as FY 2009.

Milestone:

- Release NJOY code updates required to process modified versions of international general purpose nuclear data files to RSICC (Q4).

LANL AM Subtask 4

The second phase of this subtask will demonstrate a post-processing capability to convolute these sensitivity profiles with cross-section covariance data, in order to generate overall uncertainties in calculated quantities of interest, such as k_{eff}, resulting from basic uncertainties in nuclear data.

Milestones:

- Simplify, generalize, and document the user interface for generating sensitivity profiles with MCNP5 and release it to RSICC (Q4).
- Develop a capability for convoluting MCNP5-generated sensitivity profiles with cross-section covariance data (Q4).
- Demonstrate that this capability can be used to calculate uncertainties in quantities such as k_{eff} resulting from uncertainties in nuclear data (Q4).
- Compare the results with comparable results from TSUNAMI (Q4).
- Issue a report on the results (Q4).

FY 2011

LANL AM Subtask 3

The scope for this task is the same as FY 2009.

Milestone:

- Release new base version of NJOY and revised user manual to RSICC (Q4).

LANL AM Subtask 4

The third phase of this subtask will simplify the user interface for convoluting sensitivity profiles with covariance data so that this functionality will be available to the general NCS user community. At this point, the path forward for addressing any additional NCS priority needs will be assessed. One specific avenue to explore is whether MCNP functionality developed in this project can be made interoperable with Oak Ridge's TSUNAMI system, so that users can make full use of TSUNAMI's extensive capabilities based on calculated results from either ORNL or LANL transport codes.

Milestones:

- Simplify, generalize, and document the user interface for convoluting MCNP5-generated sensitivity profiles with cross-section covariances and release this to RSICC (Q4).
- Assess possibilities for integrating MCNP results with capabilities of the TSUNAMI system (Q4).
- Assess future requirements of the NCS community. Out-year funding may be requested for extending this work, depending on the results of this study (Q4).

FY 2012

LANL AM Subtask 3

The scope for this task is the same as FY 2009.

Milestone:

- Release NJOY code updates required to process new ENDF formats to RSICC (Q4).

FY 2013

LANL AM Subtask 3

The scope for this task is the same as FY 2009.

Milestone:

- Release NJOY code updates required to process modified versions of international general purpose nuclear data files to RSICC (Q4).

FY 2010 through FY 2013

LANL AM Subtask 5

The LANL Subtask 5 description/scope remains the same as FY 2009. The milestones vary by FY.

Milestones:

- Implement a test for population size and other new diagnostics into MCNP, and issue a report (FY 2010, Q1).
- Make presentations to the OECD/NEA Expert Group on Source Convergence and to NCS users at the summer ANS meeting (FY 2010, Q3).
- Implement a direct adjoint calculation into a production version of MCNP and release to RSICC (FY 2010, Q4).
- Provide additional reports and documentation on application to practical NCS problems to RSICC (FY 2011, Q4 and FY 2013, Q4).
- Extend the importance (adjoint) capability to integrate it with TSUNAMI and Tool for Sensitive and Uncertainty Analysis of Response Functionals Using Experimental Results (TSURFER) applications from ORNL (FY 2012, Q4).

LLNL AM SUBTASKS

FY 2009

LLNL AM Subtask 1 ($150K)

Maintain existing state-of-the-art computational methods in nuclear data processing, geometry modeling, data testing, and Monte Carlo methods. Also, participate in NCSP activities including Critical-Subcritical Experiment Design Team (C_edT), CSEWG, and NDAG.

Milestone:

- Provide status in NCSP Quarterly Progress Reports (Q1, Q2, Q3, Q4).

FY 2010 through FY 2013

For Lawrence Livermore National Laboratory (LLNL) FY 2010 through FY 2013, the subtask description/scope and milestone is the same as FY 2009.

ORNL AM SUBTASKS

FY 2009

ORNL AM Subtask 1 ($300K)

RSICC: Collect, update, package, and distribute software and associated nuclear data libraries to the criticality safety community (i.e., SCALE, MCNP, VIM, and COG and nuclear data processing (i.e., NJOY and SAMMY). Also, test and disseminate processed nuclear data associated with the software.

Milestones:

- Distribute SCALE 6 (Q4).
- Distribute new MCNP/MCNPX/MCNPXDATA (Q4).
- Distribute available and newly packaged software to the NCS community requesters at prorated cost (<$600 per package), with distribution totals provided in NCSP Quarterly Progress Reports (Q1, Q2, Q3, Q4).
- Publish monthly newsletters to announce software updates, conferences, and workshops newsletters (Q1, Q2, Q3, Q4).
- Notify NCSP Manager of major new software releases so an announcement can be made to the CSCT and placed on the NCSP Website (Whenever release is made).

ORNL AM Subtask 2 ($50K)

Software and data exchange with the NEA and the Japan Research Institute of Science and Technology (RIST): Through international agreements with software and data centers located at the OECD/NEA and the Japan RIST, RSICC is able to distribute domestic software world-wide and obtain software developed in other countries (domestic software is distributed based on export control rules appropriate for the software).

Milestone:

- Continue software and information exchange with the NEA data bank and the Japan RIST to obtain software updates of relevance to the NCSP status of these exchanges will be provided in NCSP Quarterly Progress Reports (Q1, Q2, Q3, Q4).

ORNL AM Subtask 3 ($30K)

Maintenance of Electronic Notebooks: For key software with a large user base (e.g., MCNP and SCALE), RSICC maintains electronic notebooks that help facilitate lessons-learned communication among users and between users and developers.

Milestone:

- Maintain and update RSICC electronic user notebooks for MCNP and SCALE and provide status in NCSP Quarterly Progress Reports (Q1, Q2, Q3, Q4).

ORNL AM Subtask 4 ($585K)

SCALE/KENO/TSUNAMI Software Quality Assurance (SQA) Maintenance: This task supports ongoing maintenance to sustain and continually improve SCALE, including code/data enhancements; SQA; V&V; adaptability to various computing platforms and compilers; development of additional Graphical User Interface (GUI) capabilities and Hyper Text Machine Language output; and publication of user documentation. During FY 2009 the GUI capabilities for SCALE will begin the transition to a Java-based text editor program called ExSITE (Extensible SCALE Intelligent Text Editor) that will retain a simplified input interface for the user while allowing users to edit and manipulate existing input and output files.

Milestones:

- Issue an annual SCALE maintenance report (Q1).
- Publish semiannual newsletters to users to communicate software updates, user notices, generic technical advice, and training course announcements (Q2, Q4).
- Provide ongoing SCALE SQA maintenance activities (Q4).
- Develop Criticality Safety Analysis Sequences/KENO input file capability into ExSITE (Q4).
- Complete migration of SCALE SQA maintenance to the GForge software maintenance system (Q4).
- Provide ongoing website maintenance including posting software updates for users to download, validation reports and other technical publications, training course schedules, and registration. Provide a status of these activities in NCSP Quarterly Progress Reports (Q1, Q2, Q3, Q4).

ORNL AM Subtask 5 ($105K)

Provide SCALE/KENO/TSUNAMI user assistance and training: KENO and TSUNAMI training courses are offered in the spring and fall of each year at ORNL to promote expertise and safety in code applications by users. In addition, one training course will be offered each year to university nuclear engineering faculty and students at no charge. Technical assistance to users is provided through scalehelp@ornl.gov.

Milestones:

- Conduct semiannual training courses at ORNL, subject to sufficient enrollment (Q1, Q3).
- Provide ongoing responses to user technical questions via email and SCALE electronic user notebook (Q1, Q2, Q3, Q4).
- Provide a status of these activities in NCSP Quarterly Progress Reports (Q1, Q2, Q3, Q4).

ORNL AM Subtask 6 ($120K)

AMPX Development and Maintenance: Ensure the AMPX software is up-to-date and in conformance with ENDF/B formats and procedures. In addition, the PUFF-IV covariance

processing package, which is part of AMPX, is distributed by RSICC and the OECD/NEA data bank for users producing covariance data libraries for radiation transport analyses. With the release of PUFF-IV in Calendar Year 2006, ORNL has received requests for user support, and the subtask provides for continued user support and updates to the software in current use. In addition, the subtask provides for the development of enhancements to the AMPX software to enable improved nuclear data processing capabilities in addition to providing new reaction physics capabilities needed to support radiation transport methods development and analyses (e.g., coupled energy/angle covariance data, continuous-energy adjoint capabilities, etc.).

Milestones:

- Complete testing of AMPX procedures to produce unified continuous-energy data libraries (i.e., single format for CENTRM and CE-KENO) for release with SCALE 6 (Q1).
- Complete SCALE ExSITE GUI tool to execute AMPX and parse output, streamline production, and testing of cross-section data libraries for SCALE (Q4).
- Complete PUFF-IV covariance processing package and submit to RSICC (Q4).

ORNL AM Subtask 7 ($190K)

Cross-Section Library Production: Produce new and updated cross-section and covariance data libraries for SCALE criticality safety analyses software.

Milestones:

- Complete testing of ENDF/B-VII.0 libraries for SCALE 6 release (Q1).
- Produce and test the fine group (400+) ENDF/B-VII.0 library for SCALE (Q4).
- Produce and test the comprehensive covariance data library for SCALE that includes approximate covariance data provided by Brookhaven National Laboratory (BNL), LANL, and ORNL (Q4).
- Process ORNL Nuclear Data NCSP evaluations (cross-section and covariance data) for testing with SCALE for criticality safety applications (Q4).

ORNL AM Subtask 8 ($250K)

TSNUMANI-3D: Develop a new version of TSUNAMI-3D to give users access to the flexible geometry modeling capabilities of KENO-VI with a variable spatial mesh for coupling the forward and adjoint calculations. Develop and test an approach for generating adjoint fluxes in Continuous Energy (CE) with KENO. Also, several improvements are planned to optimize the use of computational resources in the TSUNAMI versions of the resonance self-shielding codes. Finally, this task will support ORNL's participation in the OECD/NEA WPNCS expert group on Uncertainty Analysis for Criticality Safety Assessment.

Milestones:

- Release optimized TSUNAMI resonance self-shielding codes to RSICC (Q4).
- Complete prototypic KENO V.a and KENO-VI TSUNAMI-3D with advanced meshing schemes (Q4).
- Develop and test adjoint approach in CE-KENO (Q4).
- Participate in OECD/NEA WPNCS expert group on uncertainty analysis for criticality safety assessment (Q4).

ORNL AM Subtask 10 ($75K)

Using current needs as a guideline, identify approximately 100 to 200 International Criticality Safety Benchmark Evaluation Project (ICSBEP) benchmark experiments per year (final range will depend on complexity of the selected benchmarks) and work to generate verified SCALE/KENO input models that accurately reflect the benchmark model description from the selected ICSBEP evaluations. Convert selected KENO inputs to SCALE/TSUNAMI inputs and generate TSUNAMI sensitivity data. Provide TSUNAMI sensitivity data files and associated input decks to the ICSBEP for distribution.

Milestones:

- Identify approximately 100 to 200 benchmark experiments (Q1).
- Provide verified SCALE inputs and ENDF/B-VI TSUNAMI data to ICSBEP for distribution (Q4).

ORNL AM Subtask 11 ($30K)

Integrate the Validation Interpretation and Bias Estimation (VIBE) tool being developed by ORNL with the DICE database of ICSBEP benchmarks to allow DICE users the ability to: identify, access, and visualize (plot) SCALE/TSUNAMI sensitivity files in any selected energy group structure, use sensitivity criteria to sort and filter the files to identify experiments that best match the application of interest, and access USLSTATS within VIBE to allow estimation of biases through trending analysis with sensitivity data or any other DICE parameters.

Milestones:

- Provide VIBE tool for identifying applicable benchmarks based on TSUNAMI data to OECD staff for inclusion with DICE (Q4).

FY 2010 through FY 2013

ORNL AM Subtasks 1 through 8

For ORNL FY 2010 through FY 2013, Subtasks 1, 2, and 3 description/scope are the same as FY 2009. The milestones vary by FY as follows:

Milestones (Subtasks 1 through 3):

- Distribute new PUFF-IV software (FY 2010, Q4).
- Distribute new SAMMY software (2010, Q4).
- Distribute new VIM software (FY 2010, Q4).
- Distribute AMPX software (FY 2011, Q4).
- Distribute SCALE 6.1 and New SAMMY (FY 2012, Q4).
- Distribute updated Nuclear Criticality Safety Slide Rule software (FY 2013, Q4).
- Continue to distribute available and newly packaged software to the NCS community requesters at prorated cost (<$600 per package) with distribution totals provided in NCSP Quarterly Progress Reports (Q1, Q2, Q3, Q4).
- Publish monthly newsletters to announce software updates, conferences, and workshops (Q1, Q2, Q3, Q4).

- Continue software and information exchange with NEA databank and Japan's RIST to obtain software updates of relevance to NCSP and NNSA, approximately 10 to 5 software updates per year (FY 2010 - 2013, Q4).
- Provide ongoing maintenance and update of RSICC electronic user notebooks for MCNP and SCALE (FY 2010 - 2013, Q4).

Milestones (Subtask 4):
- Complete user validation package with TSUNAMI sensitivity data files (produced under ICSBEP-03) for release with SCALE 6.1 (FY 2011, Q3).
- Provide ongoing SCALE SQA maintenance activities (FY 2010 - 2013, Q4).
- Release SCALE 6.1 to RSICC (FY 2011, Q4).
- Complete initial version of automated verification tool and test suite for SCALE/KENO regression testing (FY 2012, Q4).
- Release SCALE 7 to RSICC (FY 2013, Q4).
- Complete expansion of initial version of automated verification tool and test suite for SCALE/KENO regression testing to exhaustively test virtually all SCALE/KENO options (FY 2013, Q4).
- Provide an annual SCALE maintenance report (FY 2010 - 2013, Q1).
- Publish semiannual newsletters to users to communicate software updates, user notices, technical advice, and training courses (FY 2010 - FY 2013, Q2, Q4).
- Provide ongoing website maintenance: posting software updates for users to download validation reports and other technical publications, training course schedules and registration and provide status in NCSP Quarterly Progress Reports (FY 2010 - 2013, Q1, Q2, Q3, Q4).

Milestones (Subtask 5):
- Provide semiannual training courses at ORNL, subject to sufficient enrollment (FY 2010 - 2013, Q1, Q3).
- Provide ongoing responses to user technical questions via email and SCALE electronic user notebook (FY 2010 - 2013, Q1, Q2, Q3, Q4).

Milestones (Subtask 6):
- Develop automated continuous-energy data library checking utility for AMPX to perform consistency checks on SCALE CE libraries (FY 2010, Q4).
- Release AMPX cross-section processing package through RSICC and provide user support (FY 2010, Q4).
- Develop automated sequences for AMPX to produce CE and multigroup SCALE cross-section libraries (FY 2011, Q4).
- Release updated version of AMPX through RSICC (FY 2012, Q4).
- Develop covariance capability for processing energy-angle covariance data (FY 2013, Q4).
- Release updated version of PUFF covariance processing package (FY 2013, Q4).

Milestones (Subtask 7):

- Produce, test, and release ENDF/B-VII.x libraries (i.e., x represents new releases of ENDF/B-VII library released by the National Nuclear Data Center (NNDC) with SCALE (FY 2010, Q4).
- Produce, test, and release JEFF cross-section libraries for SCALE (FY 2011, Q4).
- Produce, test, and release JENDL cross-section libraries for SCALE (FY 2012, Q4).
- Produce and test ENDF/B-VIII cross-section libraries with SCALE (FY 2013, Q4).

Milestones (Subtask 8):

- Release KENO V.a and KENO-VI TSUNAMI-3D with advanced meshing schemes (FY 2010, Q4).
- Implement adjoint capability in CE-KENO (FY 2010, Q4).
- Participate in OECD/NEA WPNCS expert group on Uncertainty Analysis for Criticality Safety Assessment (FY 2010 - 2013, Q4).
- Complete prototypic CE-TSUNAMI sequences for KENO V.a and KENO-VI. (FY 2011, Q4).
- Publish results of CE-TSUNAMI testing (FY 2011, Q4).
- Complete improved prototypic version of CE-TSUNAMI (FY 2012, Q4).
- Release CE-TSUNAMI (FY 2013, Q4).

FY 2010 through FY 2013

ORNL AM Subtask 9

Develop post-processing tools that will facilitate interpretation of S/U data for use in assessing range of applicability and estimating bias and bias uncertainty for criticality safety evaluations. The vision for the development of these tools is to improve the technical capabilities of each component to provide a unified tool that has the flexibility and ease-of-use needed by the criticality safety community. The tool will be able to automatically select the best available benchmarks; estimate the bias, bias uncertainty, and administrative margin; and present the end-user with a defensible approach for their criticality safety assessment. As each new capability is developed, documentation and training materials will be updated to reflect the most recent capabilities. This task also transitions the expertise of TSUNAMI development from senior staff to junior staff to provide for the sustainability of the TSUNAMI methodologies.

Milestones:

- Develop a prototypic advanced TSUNAMI-IP with additional similarity criteria (FY 2010, Q4).
- Develop a prototypic TSURFER that independently adjusts components of experimental uncertainty (FY 2010, Q4).
- Develop a prototypic USLSTATS with multiple types of normality tests and bias and bias uncertainty calculations (FY 2010, Q4).
- Release enhanced TSUNAMI-IP, TSURFER and USLSTATS (FY 2011, Q4).
- Publish the coupled TSURFER/TSAR analysis using end-user applications (FY 2011, Q4).

- Develop a prototypic ExSITE GUI integrating capabilities of multiple analysis tools into a seamless validation and nuclear data analysis toolset (FY 2011, Q4).
- Publish a report documenting the theoretical basis for quantifying an administrative margin (FY 2011, Q4).
- Release an enhanced ExSITE GUI (FY 2012, Q4).
- Develop prototypic software for quantifying administrative margin (FY 2012, Q4).
- Publish an ExSITE analysis quantifying specific data needs (FY 2012, Q4).
- Release the ExSITE GUI incorporating administrative margin quantification techniques (FY 2013, Q4).
- Publish a comprehensive and instructive end-to-end demonstration of criticality safety evaluation methodology using end-user applications (FY 2013, Q4).

FY 2010 through FY 2013

ORNL AM Subtask 12

ICSBEP Enhancement Update models and data generated in previous years to utilize most recent features of SCALE/TSUNAMI and the most recent data libraries.

Milestone:

- Provide improved inputs and TSUNAMI data for FY 2009 models that utilize SCALE 6/TSUNAMI with ENDF/B-VII cross-sections (FY 2010, Q4).

For Subtasks 10, 11, and 12, FY 2010 through FY 2013, the description/scope and milestones are the same as FY 2009. The target number of benchmarks for FY 2010 through 2013 will be better established subsequent to completion of the FY 2009 effort. Additional outyear milestones include the following:

Milestones:

- Provide USLSTATS and further updated tools for accessing, interpreting, and visualizing TSUNAMI data to OECD staff for inclusion with DICE (FY 2010, Q4).
- Integrate TSUNAMI tools with DICE based on current capabilities (FY 2010 - 2013, Q4).
- Provide improved models and data by updating previously completed models to the current version of SCALE/TSUNAMI, utilizing the most recent data libraries (FY 2010 – 2013, Q4).

2.1.3 Analytical Methods Budget

Analytical Methods Budget, Fiscal Years 2009 – 2013					
LABORATORY	**FY 2009 ($K)**	**FY 2010 ($K)**	**FY 2011 ($K)**	**FY 2012 ($K)**	**FY 2013 ($K)**
ANL	$530	$540	$550	$560	$570
INL	$100	$300	$400	$500	$600
LANL	$1,150	$1,070	$1,100	$1,130	$1,150
LLNL	$150	$155	$160	$165	$170
ORNL	$1,735	$1,850	$1,910	$1,970	$2,030
TOTAL	$3,665	$3,915	$4,120	$4,325	$4,520

2.2 Information Preservation and Dissemination

2.2.1 Program Element Description

The Information Preservation and Dissemination (IP&D) program element preserves primary documentation supporting criticality safety and makes this information available for the benefit of the technical community. The NCSP internet website (http://ncsp.llnl.gov) is the central focal point for access to criticality safety information collected under the NCSP, and the gateway to a comprehensive set of hyperlinks to other sites containing criticality safety information resources. Additional information about the IP&D vision and strategy can be found in the *Mission and Vision of the U.S. Department of Energy, Nuclear Criticality Safety Program*, March 2008 document. A funding table is provided at the end of this program element section.

2.2.2 Approved Subtasks (FY 2009 through FY 2013)

FLUOR DANIELS (FD) IP&D SUBTASKS

FY 2009

FD IP&D Subtask 1 ($66K)
Continue improving Atlantic Richfield Hanford (ARH-600) code and database in response to beta test results. Complete documentation of CritView, and address any identified SQA issues. Complete peer review: models, inputs, analysis results, CritView application. Release a production version of the code for general use. Issue User's Guide for the production version of the code. Promote the new electronic version of CritView.

Milestone:

- Release production version of the code and user guide for general use through the NCSP website (Q4).

FY 2010 through FY 2013

Maintain the ARH-600 code and database; respond to user queries and any error identification. Consider expanding the scope to become a NCSP Electronic Handbook with multi-source input.

Milestone:

- Provide status of ARH-600 activities in NCSP Quarterly Status Reports (Q1, Q2, Q3, Q4).

FD IP&D Subtask 2 ($111K)

Continue to assess/evaluate the viability of generating a criticality safety guide for 55-gallon waste drums. If viable, develop a guide describing standard model(s) for use in criticality safety evaluations that can be applied to broad class(es) of 55-gallon waste drums. The guide would be based on the EUG input and strive for consensus in approach.

Milestones:

- Draft scope of guide provided to the NCSP Manager (Q2).
- Draft guide distributed through the NCSP website (Q4).

FY 2010

FD IP&D Subtask 1

Publish the 55-gallon drum guide.

Milestones:

- Obtain EUG concurrence with the 55-gallon drum guide (Q2).
- Issue the guide through the NCSP website (Q4).

LLNL IP&D SUBTASKS

FY 2009

LLNL IP&D Subtask 1 ($170K)

Operation and maintenance of the NCSP website: Monitor on-going operations, install monthly operating system patches, perform daily backup of the Integral Experiments Request database, upgrade web server software, perform monthly risk assessment required by NNSA cyber security policy, and maintain the computer operations.

Milestone:

- Provide status reports of website activities in NCSP Quarterly Progress Reports (Q1, Q2, Q3, Q4).

LLNL IP&D Subtask 2 ($30)
Multimedia web-based training: Revamp the training web pages to provide DOE-STD-1135-99 Section VIII Continuing Training Requirements with an example of a training module and a multi-media streaming video feature. This subtask will utilize the LLNL HS3104 training module as a starting point and the multi-media video will be added to support the multimedia web-base training.

Milestone:

- Provide status reports of website training activities in NCSP Quarterly Progress Reports (Q1, Q2, Q3, Q4).

LLNL IP&D Subtask 3 ($20)
Classified website: Study the feasibility of implementing a classified website at the LLNL Closed Labnet with the appropriate authorization and the need-to-know access to share classified nuclear data and benchmarks.

Milestone:

- Provide a report on the feasibility of a classified website to the NCSP Manager (Q3).

FY 2010 through FY 2013

For LLNL FY 2010 through FY 2013, Subtasks 1 and 2 description/scope and milestones are the same as FY 2009.

2.2.3 Information Preservation and Dissemination Budget

Information Preservation and Dissemination Budget (Fiscal Years 2009 – 2013)

LABORATORY	FY 2009 ($K)	FY 2010 ($K)	FY 2011 ($K)	FY 2012 ($K)	FY 2013 ($K)
FD	$177	$100	$100	$100	$100
LLNL	$220	$225	$230	$235	$240
TOTAL	$397	$325	$330	$335	$340

2.3 Integral Experiments

2.3.1 Program Element Description

The Integral Experiments (IE) program element maintains a fundamental capability for the DOE/NCSP to be able to perform critical, subcritical, and fundamental physics measurements, within the limits of its resources, to address specific site needs on a prioritized basis. This program element also supports maintaining a fundamental nuclear materials handling capability

which supports hands-on nuclear criticality safety training programs and various other programs for the DOE/NCSP and other government agencies. Additional information about the Analytical Methods vision and strategy can be found in the *Mission and Vision of the U.S. Department of Energy, Nuclear Criticality Safety Program*, March 2008 document. A funding table is provided at the end of this program element section.

2.3.2 Approved Subtasks (FY 2009 through FY 2013)

INL IE SUBTASKS

FY 2009

INL IE Subtask 1 ($500K)
The Institut De Radioprotection et De Sûreté Nucléaire (IRSN) has initiated an experimental program, Matériaux Interaction Réflexion Toutes Epaisseurs (MIRTE), in which integral reactivity characteristics of various structural materials will be tested in critical assemblies on the APPARATUS B facility at the Commissariat à l'Énergie Atomique (CEA) Valduc Centre.

The MIRTE Program consists of about 20 subcritical approaches extrapolated to critical conditions using the neutron amplification method. A similar number of reproducibility experiments will also be performed. Most configurations will be focused on interaction, but some will be reflected. Only low-enriched UO_2 (4.738% enriched uranium) water-moderated rod arrays with thermal energy spectra will be constructed. The experiments have been designed such that the reactivity worth of the structural materials exceeds 4%. Uncertainties in the experimental k_{eff} values are expected to be lower than 0.2%. The initial list of materials to be tested include: large absorber screens of concrete, iron, nickel, lead, zirconium, aluminum, copper, and cast-iron; thin plates of iron, nickel, copper and titanium; and reflected experiments with aluminum and SiO_2 (glass). Other materials (Mn, Cr, MgO, NaCl) could be added to the list in the future. DOE partnership on this project has also facilitated collaboration in which U.S. experimenters will have the opportunity to participate on these and/or other experiments.

Milestone:
- Provide status reports in NCSP Quarterly Progress Reports (Q1, Q2, Q3, Q4).

INL IE Subtask 2 ($80K)
Support international experiments: Procurement and evaluation of new experiments at non-U.S. facilities. Such experiments are supported through the NCSP only when U.S. facilities are unavailable to respond to specific DOE programmatic needs or when it is not feasible to conduct these experiments in U.S. facilities. When possible, LANL experimenters are given the opportunity to participate in or observe experiments that are conducted abroad.

Milestone:
- Provide status reports of international experiments in NCSP Quarterly Progress Reports (Q1, Q2, Q3, Q4).

FY 2010 through FY 2013

INEL IE Subtask 1

The results of the IRSN MIRTE Program will be compiled and evaluated in accordance with the requirements of the ICSBEP. Release of the data will be restricted to the designated beneficiaries (including DOE and all DOE national laboratories) for up to seven years after completion of the experiments. Evaluation of the data will likely extend into 2011; however, the ICSBEP is prepared to accelerate this schedule if possible.

Milestone:

- Milestones are the same as FY 2009.

For FY 2010 through 2013, Subtasks 1 and 2 description/scope and milestones are the same as FY 2009.

LANL IE SUBTASKS

FY 2009

LANL IE Subtask 1 ($450K)

Critical Experiments Facility (CEF) Operational Support at the Device Assembly Facility (DAF): This subtask directly supports the infrastructure necessary to support Integral Experiment program element operations at the DAF. DAF operations require the support of qualified and trained nuclear material handlers and operators. As the DAF continues to evolve and expand its operational status, facility maintenance and Technical Safety Requirements surveillances need to be performed. Personnel will also need to be trained to perform these activities.

Milestones:

- Update CEF operational staffing plan (Q1).
- Provide status in NCSP Quarterly Progress Reports (Q1, Q2, Q3, Q4).

LANL IE Subtask 2 ($500K)

Conduct subcritical integral experiments at the DAF: Two subcritical experiments are proposed for FY 2009. See Appendix D for details. These experiments have been determined to be the highest priority based on input from the NDAG and based on the list of approved experiments from the C_edT process.

Milestones:

- Conduct subcritical experiment with α-Pu and varying thicknesses of polyethylene in supporting Sandia National Laboratories (SNL) neutron multiplicity and gamma spectral data experiment proposed and approved by C_edT in FY 2008. Provide experimental documentation per ICSBEP Section 1 benchmark requirements. See Appendix D for Milestones.

- Conduct subcritical integral experiment with a-Pu and Tungsten and provide experimental documentation per ICSBEP Section 1 benchmark requirements. See Appendix D for Milestones.

LANL IE Subtask 3 ($450K)
Maintain and train CEF team members: Crew chiefs and crewmembers will participate in experiments and operational activities at various U.S. and international facilities. In addition, this task will also support the development of a formal qualification and certification program for NNSA approval in time to support FY 2010 CEF startup of critical assemblies.

Milestones:
- Complete all 12 modules of the CEF crew member certification program (Q4).
- Participate in training at Valduc and Sandia (Q4).
- Provide status reports on all operator training and certification activities in NCSP Quarterly Progress Reports (Q1, Q2, Q3, Q4).

LANL IE Subtask 4 ($400K)
Design and plan critical experiments to support FY 2010 and FY 2011. See Appendix D for milestones.

LANL IE Subtask 5 ($125K)
Subcritical measurement data acquisition system upgrade: Upgrade the electronics and data acquisition system for the current experimental setup used to perform subcritical benchmark measurements. The upgrade will allow for the use of other neutron noise analysis and subcritical measurement techniques. Utilization of a list-mode data acquisition system enables the application of multiple analysis techniques on the same set of data (i.e., perform analysis in both the frequency and time domain). Passive and active measurement techniques are compatible with the proposed data acquisition system. Thus, static and dynamic benchmarks are possible.

Milestones:
- Fabricate electronics to interface Pulse Arrival-Time Recording Module/PCI Mezzanine Card (PATRM/PMC) with the detection system and electronics (Q2).
- Develop and validate software to use PATRM/PMC for data acquisition (Q3).
- Develop and/or modify analysis software to use with list mode data file recorded with PATRM/PMC (Q4).

FY 2010 through FY 2013

Future NCSP activities at the DAF include continuation of subcritical experiments, maintaining the infrastructure necessary to handle Special Nuclear Materials (SNM) including job planning and safety reviews/approvals, reestablishment of hands-on criticality safety training courses for criticality safety engineers, and reestablishment of critical experiments using the critical assembly machines. The ramp up in out-year funding reflects the return to service of the machines and the expected increase in the number of integral measurements that can be carried out at the DAF.

LANL IE Subtask 1
The scope/description and milestone is the same as the second milestone in FY 2009.

LANL IE Subtask 2
The scope/description is the same as FY 2009. See Appendix D for milestones.

LANL IE Subtask 3
The scope/description is the same as FY 2009.

Milestones:
- Conduct training and dry runs in support of the Operational Readiness Review for startup of the CEF (FY 2010, Q2).
- Execute training and proficiency programs necessary to maintain certification of operators (FY 2011 - 2013, Q4).
- Provide status in NCSP Quarterly Progress Reports (Q1, Q2, Q3, Q4).

LANL IE Subtask 4
The scope/description is the same as FY 2009. See Appendix D for milestones.

LANL IE Subtask 5
The scope/description is the same as FY 2009.

Milestone:
- Assess the PATRM/PMC data acquisition system functionality by performing californium source driven measurements as well as measurements with SNM and comparing results with previous subcritical benchmark experiments (FY 2010, Q4).

LANL IE Subtask 6
Design a new horizontal split table assembly.

Milestones:
- Deliver the conceptual design of a new horizontal split table assembly (FY 2011, Q4).
- Deliver the preliminary design of a new horizontal split table (FY 2012, Q4).
- Deliver the final design of a horizontal split table (FY 2013, Q4).

LANL IE Subtask 7
Conduct hands-on criticality safety training.

Milestones:
- Develop criticality safety training (FY 2010, Q3).
- Conduct eight hands-on training classes per year (FY 2011, 2013, Q1, Q2, Q3, Q4).

LANL IE Subtask 8
Design a new solution assembly.

Milestones:
- Deliver the conceptual design of a new solution assembly (FY 2010, Q4).
- Deliver the preliminary design of a new solution assembly (FY 2012, Q4).
- Deliver the final design of a new solution assembly (FY 2013, Q4).

ORNL IE SUBTASKS

FY 2009

ORNL IE Subtask 1 ($150K)
Integration of TSUNAMI tools with the C_edT process: Experiment designs designated by NCSP Program manager will be optimized within known constraints to maximize similarity to targeted applications. Benefits of modifying designs beyond known constraints will be identified as they are revealed by utilization of TSUNAMI in the optimization process.

Milestones:
- Provide a report documenting TSUNAMI analysis for requested preliminary experiment designs to the NCSP Manager (Q3).
- Provide a report documenting TSUNAMI analysis of final experiment designs to assure intended applicability to the NCSP Manager (Q4).

ORNL IE Subtask 2 ($40K)
Integration of TSUNAMI tools with the C_edT process: Document work and provide as-built TSUNAMI data for completed experiments selected by the NCSP Program Manager. These data will be provided to the ICSBEP evaluator.

Milestone:
- Provide a report documenting TSUNAMI analysis of completed experiments to the NCSP Manager (Q4).

FY 2010 through FY 2013
For ORNL FY 2010 through FY 2013, Subtasks 1 and 2 description/scope and milestones are the same as FY 2009.

SNL IE SUBTASKS

FY 2009

SNL IE Subtask 1 ($50K; assumes $310K in Office of Nuclear Energy, Science and Technology funding)
Initiate the seven percent critical experiment.

Milestones:

- Complete the Restart of the Sandia Pulsed Reactor Facility Critical Experiment capability (Q1)
- Perform detailed 7uPCX planning (Q1, Q2).
- Execute critical experiments for one fuel element pitch (Q3, Q4).

FY 2010

SNL IE Subtask 1
Finish the seven percent critical experiment.

Milestones:

- Complete the critical experiments (Q1, Q2).
- Analyze and document the experiments (Q3).

FY 2011 through FY 2013

Conduct high priority critical experiments as directed by the NCSP Manager. Milestones are to be determined in the future.

2.3.3 Integral Experiments Budget

Integral Experiments Budget (Fiscal Years 2009 – 2013)

LABORATORY	FY 2009 ($K)	FY 2010 ($K)	FY 2011 ($K)	FY 2012 ($K)	FY 2013 ($K)
INL	$580	$500	$0	$0	$0
LANL	$1,925	$2,500	$3,300	$3,400	$3,500
ORNL	$190	$195	$205	$210	$220
SNL	$50	$415	$420	$425	$430
TOTAL	$2,745	$3,610	$3,925	$4,035	$4,150

2.4 International Criticality Safety Benchmark Evaluation Project

2.4.1 Program Element Description

The purpose of International Criticality Safety Benchmark Evaluation Project (ICSBEP) is to: (1) identify and evaluate a comprehensive set of criticality safety related experimental benchmark data; (2) verify the data, to the extent possible, by reviewing original and subsequently revised documentation, and by talking with the experimenters or individuals who are familiar with the experiments or the experimental facility; (3) evaluate the data and quantify overall uncertainties through various types of sensitivity analyses; (4) compile the data into a

standardized format; (5) perform sample calculations using standard criticality safety codes and data; and (6) formally document the work into a single source of verified, extensively peer reviewed benchmark data. Additional information about the ICSBEP vision and strategy can be found in the *Mission and Vision of the U.S. Department of Energy, Nuclear Criticality Safety Program*, March 2008 document. A funding table is provided at the end of this program element section.

A small group (six to eight members) of criticality safety, integral measurement, and nuclear data experts was established (June 2009) to review available experimental data and, based on community needs, set future benchmark priorities. The group planned and prioritized U.S. funded benchmarks for five years. Specific data are considered "high-priority" and are included in the plan if they fill immediate criticality safety needs, fill gaps in the ICSBEP integral benchmark database, are recently generated U.S. funded data (including data generated outside the U.S.), continue or enhance foreign collaboration, are expected to be of benchmark quality, or maintain U.S. capability by fostering next-generation participation. The result of this effort, a prioritized list of benchmarks, is given in Appendix C. Currently specified in Appendix C is evaluation of seven experimental series per year. The actual number will ultimately depend on the cost of each evaluation. The prioritization process is now an integral part of the ICSBEP planning effort.

2.4.2 Approved Subtasks (FY 2009 through FY 2013)

INL ICSBEP SUBTASKS

FY 2009

INL ICSBEP Subtask 1 ($1,000K)
Maintain the ICSBEP Infrastructure: ICSBEP Infrastructure includes project management, project administration, independent peer review and technical editing, graphic arts, project meeting organization, publication costs, travel for selected participants who are contributing evaluations, internet site upgrades and maintenance, minimal support for the Russian Federation and others, and participation in other NCSP activities.

Milestones:

- Hold Benchmark Prioritization Meeting (Q1).
- Conduct annual ICSBEP Technical Review Group Meeting (Q3).
- Publish the *International Handbook of Evaluated Criticality Safety Benchmark Experiments* (Q4).

INL ICSBEP Subtask 2 ($730K)
Support National Laboratory/Site/Institute Participation: Laboratory participation includes data evaluation; internal peer review; limited independent peer review; and ICSBEP meeting preparation, participation, and travel by participants at each of seven national laboratories or sites: INL, LANL, LLNL, ORNL, ANL, SRNL, and the Hanford Site. SNL and Bettis Laboratory also participate at their own expense. Participation by non-U.S. institutes that are funded through the ICSBEP are included in this task.

Milestone:

- Milestones are the same as INL ICSBEP Subtask 1.

2.4.3 International Criticality Safety Benchmark Evaluation Project Budget

International Criticality Safety Benchmark Evaluation Project Budget (Fiscal Years 2009 – 2013)

LABORATORY	FY 2009 ($K)	FY 2010 ($K)	FY 2011 ($K)	FY 2012 ($K)	FY 2013 ($K)
INL	$1,730	$1,850	$1,900	$1,950	$2,000

2.5 Nuclear Data

2.5.1 Program Element Description

The Nuclear Data (ND) program element includes the measurement, evaluation, testing, and publication of neutron cross-section data for nuclides of high importance to nuclear criticality safety analyses. The NCSP continues to improve coordination of Nuclear Data (ND) activities by fostering a strong collaborative effort among all of our national and international resources in this highly-technical area. The objective is to solve the highest priority ND problems relevant to criticality safety in a timely manner. This program element is essential for the NCSP because it provides the nuclear cross-section data required by the AM program element. Additional information about the ND vision and strategy can be found in the *Mission and Vision of the U.S. Department of Energy, Nuclear Criticality Safety Program*, March 2008 document. A funding table is provided at the end of this program element section.

2.5.2 Approved Subtasks (FY 2009 through 2013)

ANL ND SUBTASKS

FY 2009

ANL ND Subtask 1 ($240K)

Data testing and validation has proven essential to improvements in neutron evaluations. ANL will utilize a validation suite of (primarily ICSBEP) benchmarks in support of the data validation effort for ENDF/B-VII. Emphasis will be on testing and reporting performance of priority evaluations identified by the NDAG (e.g., ^{239}Pu, Ni, Cr, Mn and other structural and reflector materials, and thermal scattering data). The priority in FY 2009 will be to continue to process and data test new β evaluations developed for ENDF/B-VII.1, document their performance, and feedback results to the NDAG and the CSEWG.

Milestones:

- Provide reports to NDAG and CSEWG (Q1, Q3).

- Participate as ENDF representative in the OECD/NEA WPEC annual meeting and various subgroup activities, including the High-Priority Request List (Q3).
- Participate in ND meetings (including support succession of chairs of CSEWG Measurements and Validation Committees, member CSEWG Executive Committee, and chair CSEWG Covariance Committee (Q4).
- Document additional capability to produce covariance evaluations for ENDF (Q4)

ANL ND Subtask 2 ($25K)
Support the C_edT process to ensure proper planning and execution of integral experiments.

Milestone:
- Report status in NCSP Quarterly Status Reports (Q1, Q2, Q3, Q4).

FY 2010 through FY 2013

For ANL FY 2010 through FY 2013, Subtasks 1 and 2 description/scope and milestones are the same as FY 2009.

BNL ND SUBTASKS

FY 2009

BNL ND Subtask 1 ($235K)
Provide technical support to the NCSP.

Milestones:
- Ensure that NCSP produced ND are processed, reviewed, and included in the U.S. ENDF/B (Q1, Q2, Q3, Q4).
- Transfer neutron resonance evaluation know-how from S. Mughabghab to new staff member (Q4).
- Develop resonance covariance module using uncertainty information from the Atlas of Neutron Resonances (Q4).

FY 2010

BNL ND Subtask 1
Provide technical support to the NCSP.

Milestones:
- Ensure that NCSP produced ND are processed, reviewed, and included in the U.S. ENDF/B (Q1, Q2, Q3, Q4).
- Refine neutron resonance know-how transferred from S. Mughabghab to new staff member (Q4).
- Improve the resonance covariance module with extended use of uncertainty information from the Atlas of Neutron Resonances (Q4).

FY 2011 through FY 2013

For BNL FY 2011 through FY 2013, Subtask 1 description/scope and milestones are the same as FY 2010.

INL ND SUBTASKS

FY 2010

INL ND Subtask 1
Procurement of Targets: Highly pure ^{239}Pu and ^{240}Pu material.

Milestone:
- Manufacture targets (Q2).

INL ND Subtask 2
Conduct the Measurement Program: Differential measurements are costly and require substantial infrastructure. In order to reduce the cost per measured nuclide, it is necessary to establish a measurement program that can function, uninterrupted for several years. As a primary option, a 36-month program is proposed beginning this FY.

Milestone:
- Initiate measurement of ^{239}Pu (Q4).

FY 2011 through 2012

INL ND Subtask 2
Continue the measurement program.

Milestones:
- Complete ^{239}Pu measurements (FY 2011, Q4).
- Analyze ^{239}Pu data and deliver to BNL for evaluation (FY 2012, Q1).
- Complete ^{240}Pu measurements (FY 2012, Q2).
- Analyze ^{240}Pu data and deliver to BNL for evaluation (FY 2012, Q4).

LANL ND SUBTASKS
Refer to Appendix D for the FY 2009 through 2013 schedule, milestones and deliverables associated with specific nuclear data measurement, evaluation, and publication.

FY 2009

LANL ND Subtask 1 ($490K)
Provide ND evaluation support.

Milestone:

- Incorporate improved theoretical treatment of three-body breakup channels in the EDA code (Q4).

LANL ND Subtask 2 ($25)

Explore the possibility of using Los Alamos Neutron Science Center (LANSCE) for Precision Differential Cross-Section Measurements. Meet with colleagues from ORNL and elsewhere to learn the details of the NCSP differential cross-section measurement program requirements and current capabilities at Oak Ridge Electron Linear Accelerator (ORELA).

Milestone:

- Participate in NDAG and represent NCSP in LANSCE development (Q4).

FY 2010

LANL ND Subtask 1

Provide ND evaluation support.

Milestone:

- Make code improvements to McGNASH and KALMAN that address methodology for assigning high-fidelity uncertainties (covariances) to cross-section calculations (Q4).

LANL ND Subtask 2

Develop a plan, in collaboration with colleagues at ORELA, to field the necessary experiments at the upgraded WNR and how to best leverage available systems and expertise along with detector system upgrade recommendations, if appropriate. The plan will provide the NCSP with a viable option plan for their vision to sustain world-class expertise and capabilities to continually improve measured differential cross-sections.

Milestone:

- Develop a documented plan, including milestones and budgets, to carry out NCSP differential cross-section measurement program at LANSCE – Weapons Neutron Research (LANSCE/WNR) (Q4).

FY 2011 through 2013

LANL ND Subtask 1

Provide ND evaluation support as delineated in Appendix D.

LANL ND Subtask 2

Continuation of this subtask is dependent on the disposition of ORELA, progress on LANSCE refurbishment, and other outcomes well outside this individual task. However, as resolution of these issues becomes clear with time, specific FY 2011 through FY 2013 milestones and budgets (if any) will be prepared. The work in FY 2009 and FY 2010 enables preparation for whatever circumstances occur in FY 2011 and beyond.

ORNL ND SUBTASKS

Refer to Appendix D for FY 2009 through 2013 for schedule, milestones, and deliverables associated with specific nuclear data measurement, evaluation, and publication. Milestones not contained in Appendix D are delineated below.

FY 2009

ORNL ND Subtask 1 ($700K)

Cross-Section Measurements: Perform differential resonance-region cross-section measurements of high-priority nuclides needed for nuclear criticality safety analyses. Measurements will be performed at a facility(ies) with demonstrated measurement capabilities in the resonance region. NCSP resonance region cross-section measurements will be performed in accordance with the differential ND measurement options recommended in response to NDAG Tasking 2007-03. Beginning in FY 2009, ORNL will initiate activities needed to perform collaborative resonance-region measurements at facilities such as Institute for Reference Materials and Measurements (IRMM) and Rensselaer Polytechnic Institute (RPI). At the projected measurement funding level in FY 2009, ORNL should be able to use the ORELA facility to measure the tungsten isotopes identified in Appendix D; however, with the planned out year funding reduction, there will be increasing reliance upon domestic and international collaborations to complete NCSP measurements. In addition, the NDAG has identified differential measurement needs for thermal scattering moderators. ORNL will pursue emerging international collaborative measurement opportunities with the Argentina National Atomic Energy Commission, Bariloche, Argentina which has demonstrated capabilities for both measuring coupled energy-angle data for thermal scattering and producing thermal evaluations. In FY 2009 and FY 2010, ORNL will work to establish international collaborations to demonstrate a new thermal scattering measurement and evaluation capability to address NCSP thermal moderator data needs.

Milestones:

- Provide status of international collaboration/subcontracts as needed to complete out-year NCSP measurements (e.g., IRMM, Argentina National Atomic Energy Agency, etc.) in NCSP Quarterly Progress Reports (Q1, Q2, Q3, Q4).
- Participate in RPI measurements of Gd and Dy (Q2, Q3).

ORNL ND Subtask 2 ($330K)

SAMMY Nuclear Modeling: Develop and maintain analysis capabilities for the SAMMY software that is an essential computational tool used to analyze measured ND and prepare resonance-region cross-section evaluations with covariance data. As part of this subtask, the nuclear modeling specialist performs ongoing maintenance, capability improvements, and software training for the SAMMY software. With the retirement of the long-time SAMMY developer, ORNL will implement the SAMMY transition plan to develop the next generation SAMMY expert. In addition, the SAMMY analysis software will be enhanced to perform improved resonance parameter analyses needed to support NCSP evaluation efforts.

Milestones:

- Provide bi-annual updates to SAMMY software to support NCSP data evaluation efforts and needs (Q2, Q4).
- Deliver new SAMMY package to RSICC (Q4).
- Provide a final report on implementation of the SAMMY transition plan to the NCSP Manager (Q4).
- Implement an improved Unresolved Resonance Region (URR) covariance analysis methodology (Q4).

ORNL ND Subtask 3 ($750K)

Nuclear Data Evaluation: Utilize information from differential measurements, integral measurements, and nuclear modeling codes to develop improved data evaluations with covariance data for distribution with the ENDF/B file system. Furthermore, the development of new cross-section evaluations is most efficiently accomplished by international and domestic collaborations, through participation in CSEWG activities, NDAG activities, and international working groups sponsored by the International Atomic Energy Agency (IAEA) and the OECD. ORNL will perform cross-section analyses to produce resonance-region evaluations that will be combined with high-energy cross-section evaluations obtained through collaborations with LANL and international research institutions such as IRMM, IAEA, etc. Beginning in FY 2009, ORNL will initiate and lead an international WPEC subgroup to provide technical recommendations for improving the unresolved region.

Milestones:

- Participate in the NDAG meetings (Q1, Q3).
- Participate in the OECD/NEA WPEC nuclear subgroup activities, annual meeting (Q3).
- Obtain high-energy cross-section evaluations with covariance data for ^{58}Ni, ^{60}Ni, ^{52}Cr, and ^{53}Cr from IAEA collaboration (Note: not reflected in Gantt charts) (Q4).
- Initiate and chair the WPEC subgroup to improve URR analysis methodology (Q4).
- Complete an investigation of Single Level Breit Wigner unresolved resonance evaluation for ^{235}U and ^{238}U relative to possible improved URR analysis methodology (Q4).
- Participate in the CSEWG meeting and chair the ENDF/B formats committee (Q4).
- Provide status report of international collaboration/subcontracts as needed to complete out-year NCSP measurements (e.g., IRMM, Argentina National Atomic Energy Agency, etc.) in NCSP Quarterly Progress Reports (Q1, Q2, Q3, Q4).

ORNL ND Subtask 4 ($20K)

The NCSP plans to investigate resonance region measurement options in the event ORELA is not available to perform cross-section measurements. In the U.S., LANL and RPI are two facilities that could be utilized in the future provided upgrades are made to enable resonance region capture and transmission measurements throughout the keV region. In FY09, LANL ND Subtask 2 will provide support for LANL to develop a plan in consultation/collaboration with ORNL to upgrade WNR to perform resonance region measurements. In addition, RPI has

identified specific upgrades that can be performed to enable capture measurements throughout the keV region (documented in response to NDAG Tasking 2007-03). ORNL Subtask 4 will enable ORNL to provide the requisite interface consultation support as needed to LANL and/or RPI to facilitate planning for possible measurement capability upgrades at their respective facilities.

Milestone:

- Issue a letter report to the NCSP Manager documenting work with LANL and/or RPI on resonance region measurement improvements (Q4).

FY 2010 through FY 2013

For ORNL 2010 through FY 2013, the subtask description/scope remains the same as FY 2009. Milestones associated with specific nuclear data measurement, evaluation, and publication are delineated in Appendix D. Additional outyear milestones are delineated below.

ORNL ND Subtask 1

Milestone:

- Complete a plan to establish fission and scattering (energy and angle) resonance region measurement capability to address NCSP nuclear data needs (FY 2013, Q4)

ORNL ND Subtask 2

Milestones:

- Through collaboration with CEA, implement new URR analysis methodology to improve NCSP resonance evaluations (FY 2010, Q4).
- Deliver updated SAMMY package to RSICC (Q4).

ORNL ND Subtask 3

Milestones:

- Attend NDAG meetings (Q1, Q3).
- Attend OECD/NEA WPEC nuclear subgroup activities, annual meeting (Q3).
- Prepare draft recommendations for new URR methodology and implementation in ENDF/B (FY 2010, Q4).
- Attend CSEWG and WPEC meetings (Q4).

RPI ND SUBTASKS

FY 2009

RPI ND Subtask 1 ($182K)

Conduct measurements of isotopically enriched metallic samples of Gd and Dy.

Milestone:

- Detailed milestones are contained in Appendix D.

FY 2010

RPI ND Subtask 2

Complete the SAMMY analysis.

Milestones:

- Complete SAMMY analysis on Gd sample (Q2).
- Complete SAMMY analysis on Dy sample (Q3).
- Provide a report to the NCSP Manager and a publication describing the measurements, data reduction, SAMMY analysis and results (Q4).

FY 2011 through FY 2013

Additional work at RPI depends on success of FY 2009 through FY 2010 work and the outcome of alternative differential ND measurement option studies.

2.5.3 Nuclear Data Budget

Nuclear Data Budget (Fiscal Years 2009 – 2013)

LABORATORY	FY 2009 ($K)	FY 2010 ($K)	FY 2011 ($K)	FY 2012 ($K)	FY 2013 ($K)
ANL	$265	$270	$275	$280	$285
BNL	$235	$240	$250	$260	$270
INL	$0	$840	$850	$850	$850
LANL	$515	$530	$540	$550	$560
ORNL	$1,800	$1,800	$1,820	$1,840	$1,860
RPI	$182	$30	$0	$0	$0
TOTAL	$2,997	$3,710	$3,735	$3,780	$3,825

2.6 Training and Education

2.6.1 Program Element Description

The Training and Education (T&E) program element will continue to offer hands-on training courses as needed by DOE and identify and develop training needs and resources in areas where no suitable materials exist. The primary purpose of the T&E element is to maintain the technical

capabilities of criticality safety professionals and provide for the training and education of people entering the criticality safety discipline from related scientific fields. Additional information about the Training and Education vision and strategy can be found in the *Mission and Vision of the U.S. Department of Energy, Nuclear Criticality Safety Program*, March 2008 document. A funding table is provided at the end of this program element section.

2.6.2 Approved Subtasks (FY 2009 through FY 2013)

ANL T&E SUBTASKS

FY 2009

ANL T&E Subtask 1 ($52K)
Develop two additional Nuclear Criticality Safety Engineer Training (NCSET) modules that will be posted on the NCSP website as a training resource for the complex.

Milestones:

- Develop a tutorial for use of the DICE system to query the ICSBEP database (Q2).
- Develop a module on burnup credit for criticality safety (Q4).

FY 2010 through FY 2013

Each year two new NCSET modules in traditional format or one advanced multimedia format module will be completed and posted to the NCSP website. Suggestions for topics for new modules are solicited each year from the user community, but the current proposed list includes: criticality accident analysis techniques and comparison to historical events, tutorial on subcritical measurements techniques and use of subcritical measurements as validation benchmarks, and advanced fuel cycle criticality safety issues. Milestones are still to be determined.

LLNL T&E SUBTASKS

FY 2009

LLNL T&E Subtask 1 ($400K)
Continue to offer a unique "hands-on" criticality safety training course for DOE practitioners and workers who handle SNM. This established training course received the "Award for Technical Excellence" from the American Nuclear Society at its national meeting in November 2006. The training consists of several academic and experimental modules designed to meet the training and qualification requirements of DOE-STD-1135-99. A complete course description is available at: http://ncsp.llnl.gov/HS3201/CritClass_Descript.html. These classes may be tailored to the interests of special groups with the concurrence of the NCSP Manager.

Milestones:

- Provide a class schedule for NCSP Manager approval (Q1).
- Conduct eight classes in accordance with the approved schedule (Q1, Q2, Q3, Q4).

FY 2010 through FY 2011

LLNL T&E Subtask 1
Scope and milestones are the same as FY 2009.

LLNL T&E Subtask 2
Develop and experimentally demonstrate tutorials on two subcritical noise methods; namely, the Feynman variance-to-mean method and pulse die-away method using existing materials and equipment.

Milestones:
- Complete tutorial documentation (FY 2010, Q4).
- Conduct tutorials (FY 2011, Q3).

FY 2011 through 2012

LLNL T&E Subtask 3
Transfer equipment for these courses to DAF by 2012.

Milestones:
- Prepare materials for shipment (2011, Q4).
- Ship materials to DAF (2012, Q4).

ORNL T&E SUBTASKS

FY 2009

ORNL T&E Subtask 1 ($150K)
Manage the collaborative development for the planning, designing, and suggested scheduling for the multi-faceted and phased NCSP training program.

Milestone:
- Provide a written report on a consensus design for a comprehensive NCSP training program for criticality safety engineers, facility managers, supervisors and fissionable material handlers to the NCSP Manager (Q4).

FY 2010

ORNL T&E Subtask 2
Design four consolidated pilot education and training classes at sites of specialization (e.g., SNL water lattice critical experiment, CEF metal systems, CEA Valduc solution systems, etc.) as appropriate. Curricula should include, as a minimum, the following:

- Nuclear theory
- Calculational methods
- Critical experiments, accidents, data, and emergency preparedness

- Standards, regulations, orders, and guides, including the Price-Anderson Amendments Act
- NCS evaluations, safety analysis, control, and risk assessment
- Criticality accident causal factors and analysis, alarm, and detection
- Accountability and non-destructive analysis, practices, and reliability
- Hands-on experimental training
- Processes and facility education, training, and observation/tours
- Personnel responsibilities
- Integrated Safety Management and NCS

Milestones:

- Complete preliminary site-consolidated training program design (Q1).
- Conduct preliminary program design peer review (Q2).
- Publish site-consolidated training program plan (Q2).

FY 2011

ORNL T&E Subtask 3

Initiate pilot training and refine and extend education and training classes

Milestones:

- Initiate the first of 4-per-year on-site consolidated training programs (Q1).
- Complete the fourth of 4-per-year training programs (Q4).

FY 2012 and FY 2013

ORNL T&E Subtask 4

Provide four comprehensive education and training classes each year.

Milestones:

- Initiate the first of 4-per-year revised training modules (FY 2012, Q1).
- Complete the fourth of 4-per-year revised training modules (FY 2012, Q4).
- Maintain 4-per-year education and training modules in concert with on-site operations-familiarization training programs (Q4).

SNL T&E SUBTASKS

FY 2009

SNL T&E Subtask 1 ($285K)

Sandia-specific classroom training necessary for the CEF operators to participate in Sandia critical experiment operations will be developed and delivered. The facility capability will be maintained by operating a minimum of one critical experiment per quarter. CEF operators will be invited to participate to the maximum extent possible in all critical experiments conducted in the Sandia facility.

Milestones:

- Develop Sandia-specific CEF operator training documentation (Q1).
- Qualify CEF operators to participate in Sandia critical experiments (Q4).
- Maintain facility capability and report status in NCSP Quarterly Progress Reports (Q1, Q2, Q3, Q4).

FY 2010 through FY 2013

For SNL FY 2010 through FY 2013, subtask scope transitions from CEF operator training to general NCSP hands-on criticality safety training. The milestones are listed below.

Milestones:

- Support NCSP hands-on training (Q1, Q2, Q3, Q4).
- Maintain facility capability (Q1, Q2, Q3, Q4).

2.6.3 Training and Education Budget

Training and Education Budget (Fiscal Years 2009 – 2013)

LABORATORY	FY 2009 ($K)	FY 2010 ($K)	FY 2011 ($K)	FY 2012 ($K)	FY 2013 ($K)
ANL	$52	$54	$56	$58	$60
LLNL	$400	$512	$675	$150	$0
ORNL	$150	$400	$420	$440	$460
SNL	$285	$260	$265	$270	$275
TOTAL	$887	$1,226	$1,416	$918	$795

3.0 Nuclear Criticality Safety Program Support

The NCSP Manager is supported by several groups of criticality safety experts. These groups are described in this section. Complete information about these groups (membership, charter, taskings, etc.) can be found on the NCSP website. A funding table is provided at the end of this section.

3.1 Criticality Safety Support Group

The CSSG is comprised of recognized criticality safety experts from DOE offices and contractor organizations. The primary function of the CSSG is to provide operational and technical expertise to the DOE through the NCSP Manager. The CSSG also provides the NCSP Manager with technical reviews of orders, standards, rules and guides issued by DOE related to criticality

safety. In addition, the CSSG responds to requests from the NCSP Manager for information, technical reviews, and evaluations of criticality safety issues throughout the complex.

3.1.1 Approved Subtask (FY 2009)

The CSSG is the only group that receives budget support for all of its contractor members (8 CSSG contractor members x $45K/members + $20K for the CSSG Chair + $20K for the CSSG Deputy Chair).

3.2 Nuclear Data Advisory Group

The NDAG, through making recommendations to the NCSP Manager, enhances the coordination of the NCSP ND element work program with current and future DOE needs and promotes the integration of this work program with other elements of the NCSP. The NDAG Chair receives some funding to support his management of the NDAG. This is included in the budget table at the end of the section.

3.3 Criticality Safety Coordinating Team

The CSCT is the group of federal staff providing line oversight for criticality safety at the field level. The NCSP Manager is the Chair of the CSCT. The CSCT members at the site offices ensure that the contractors implement DOE criticality safety orders and standards in their role as individual line management safety oversight. They also have a pivotal role to play in understanding the technical infrastructure needs at the site level that the NCSP provides. The primary function of the CSCT is to ensure uniformity of criticality safety programs and compliance throughout all the sites. They form the cadre of federal criticality safety subject matter experts and will also assist the site office managers and headquarters with monitoring criticality safety programs through site assistance visits. There are no funded subtasks for the CSCT.

3.4 End-User Group

The EUG consists of contractor nuclear criticality safety personnel formed to advise the NCSP Manager on infrastructure needs of criticality safety practitioners and to provide feedback on the products of the NCSP. The EUG participation in the NCSP improves efficiency of operations and enhances safety by ensuring the deliverables are useful and implementable. There are no funded subtasks for the end users.

3.5 Criticality Safety Program Support

NCSP Support Activities (Fiscal Years 2009 – 2013)

	FY 2009 ($K)	FY 2010 ($K)	FY 2011 ($K)	FY 2012 ($K)	FY 2013 ($K)
CSSG	$400	$400	$400	$400	$400
NDAG Chair (ANL)	$25	$26	$27	$28	$29
TOTAL	$425	$426	$427	$428	$429

Appendix A
Nuclear Criticality Safety Program Task Managers

ANL

Richard McKnight
Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439
Telephone: 630-252-6088
Facsimile: 630-252-4500
E-Mail: rdmcknight@anl.gov

BNL

Pavel Oblozinsky
National Nuclear Data Center
Building 197D
P.O. Box 5000
Brookhaven National Laboratory
Upton, NY 11973-5000
Telephone: 631-344-2814
Facsimile: 631-344-2806
E-Mail: oblozinsky@bnl.gov

Fluor Hanford

Raymond Puigh
Fluor Government Group
P.O. Box 1050
MSIN T5-54
Richland, WA 99352
Telephone: 509-376-3766
Facsimile: 509-373-2752
E-Mail: Raymond.Puigh@rl.gov

INL

J. Blair Briggs
Idaho National Laboratory
2525 North Fremont
P.O. Box 1625
Idaho Falls, ID 83415-3860
Telephone: 208-526-7628
Facsimile: 208-526-2930
E-Mail: j.briggs@inl.gov

LANL

Robert Margevicious
Los Alamos National Laboratory
P.O. Box 1663
Los Alamos, NM 87545
Telephone: 505-606-0109
Facsimile: 505-665-5931
E-Mail: margevicious@lanl.gov

LLNL

David Heinrichs
Lawrence Livermore National Laboratory
P.O. Box 808
Mail Stop 198
7000 East Avenue
Livermore, CA 94551-0808
Telephone: 925-424-5679
Facsimile: 925-423-2854
E-Mail: heinrichs1@llnl.gov

ORNL

Cecil Parks
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, TN 37831-6170
Telephone: 865-574-5280
Facsimile: 865-574-3527
E-Mail: parkscv@ornl.gov

RPI

Yaron Danon
Director Gaerttner LINAC Laboratory
Department of Mechanical, Aerospace and Nuclear Enginering
NES 1-9 Rensselaer Polytechnic Institute
110 8th Street
Troy, NY 12180-3590
Telephone: 518-276-4008
Facsimile: 518-276-4832
E-Mail: danony@rpi.edu

SNL

Gary a. Harms
Sandia National Laboratory
P.O. Box 5800
Albuquerque, NM 87185-1146
Telephone: 505-845-3244
Facsimile: 505-284-3651
E-Mail: gaharms@sandia.gov

Appendix B
Work Authorization Statements for
Nuclear Criticality Safety Program Funding for Execution Year (FY 2009)
Provided to the NA-17 Budget Office in September 2008

Tasks: Analytical Methods, Nuclear Data, Training and Education, and the Criticality Safety Support Group
Argonne National Laboratory (ANL): $937K

Funds are provided to ANL to continue supporting analytical methods and associated cross-section processing codes, and Nuclear Data activities, including chairing the Nuclear Data Advisory Group, and development of Nuclear Criticality Safety Engineer Training (NCSET) modules as delineated in the Nuclear Criticality Safety Program (NCSP) Five-Year Plan dated September 2008, or as directed by the NCSP Manager. Funds are also provided for chairing the Criticality Safety Support Group (CSSG) as it provides technical support to the NCSP Manager regarding planning and execution of the NCSP. With approval of the NCSP Manager, the CSSG may also provide technical assistance to other Department of Energy (DOE) and DOE Contractor organizations. Quarterly reports on the status of all tasks shall be provided to the NCSP Manager no later than the last day of the month following the end of the quarter.

ANL POC: Richard McKnight (630-252-6088)
DOE POC: Jerry McKamy, NNSA (301-903-8031)

Task: Nuclear Data
Brookhaven National Laboratory (BNL): $235K

Funds are provided to BNL to continue Nuclear Data support including shepherding new data evaluations through the Cross Section Evaluation Working Group process and subsequent publication of these data in the United States Evaluated Nuclear Data File; transferring technical skills to the next generation; and improving the BNL covariance model as delineated in the Nuclear Criticality Safety Program (NCSP) Five-Year Plan dated September 2008, or as directed by the NCSP Manager. Quarterly reports on the status of all tasks shall be provided to the NCSP Manager no later than the last day of the month following the end of the quarter.

BNL POC: Pavel Oblozinsky (631-344-2814)
DOE POC: Jerry McKamy, NNSA (301-903-8031)

Task: Information Preservation and Dissemination
Fluor Hanford: $177K

Funds are provided to Fluor Hanford for the continued revision of ARH-600 and continuation of the 55 gallon drum study as delineated in the and Nuclear Criticality Safety Program (NCSP) Five-Year Plan dated September 2008 or as directed by the NCSP Manager. Quarterly reports on the status of all tasks shall be provided to the NCSP Manager no later than the last day of the month following the end of the quarter.

Fluor Hanford POC: Raymond Puigh (509-376-3766)
DOE POC: Jerry McKamy, NNSA (301-903-8031)

Tasks: Analytical Methods, Integral Experiments, International Criticality Safety Benchmark Evaluation Project and the Criticality Safety Support Group
Idaho National Laboratory (INL): $2,500K

Funds are provided to the INL to conduct a rudimentary multiphysics analytical method simulation; to oversee United States participation in the Institut de Radioprotection et de Sûreté Nucléaire (IRSN) Structural Materials Experiments Program (MIRTE), and to conduct the International Criticality Safety Benchmark Evaluation Project (ICSBEP) as delineated in the Nuclear Criticality Safety Program (NCSP) Five-Year Plan dated September 2008, or as directed by the NCSP Manager. Funds are also provided for Criticality Safety Support Group (CSSG) technical support to the NCSP Manager regarding planning and execution of the NCSP ($45K for WSMS and $45K for SRNS). With approval of the NCSP Manager, the CSSG may also provide technical assistance to other Department of Energy (DOE) and DOE Contractor organizations. Quarterly reports on the status of the multiphysics simulation and ICSBEP and MIRTE tasks shall be provided to the NCSP Manager no later than the last day of the month following the end of the quarter.

INL POC: Blair Briggs (208-526-7628)
DOE POC: Jerry McKamy, NNSA (301-903-8031)

Tasks: Analytical Methods, Integral Experiments, Nuclear Data, and the Criticality Safety Support Group
Los Alamos National Laboratory (LANL): $3,635K

Funds are provided to LANL to conduct nuclear criticality integral experiments, MCNP support, and Nuclear Data support as delineated in the Nuclear Criticality Safety Program (NCSP) Five-Year Plan dated September 2008, or as directed by the NCSP Manager. Funds are also provided for Criticality Safety Support Group (CSSG) technical support to the NCSP Manager regarding planning and execution of the NCSP. With approval of the NCSP Manager, the CSSG may also provide technical assistance to other Department of Energy (DOE) and DOE Contractor organizations. Quarterly reports on the status of all tasks shall be provided to the NCSP Manager no later than the last day of the month following the end of the quarter.

LANL POC: Robert Margevicious (505-606-0109)
DOE POC: Jerry McKamy, NNSA (301-903-8031)

Tasks: Analytical Methods, Information Preservation and Dissemination, Training and Education, and the Criticality Safety Support Group
Lawrence Livermore National Laboratory (LLNL): $815K

Funds are provided to LLNL to conduct hands-on criticality safety training and maintain the DOE Nuclear Criticality Safety Program (NCSP) website, as delineated in the NCSP Five-Year

Plan dated September 2008, or as directed by the NCSP Manager. Funds are also provided for Criticality Safety Support Group (CSSG) technical support to the NCSP Manager regarding planning and execution of the NCSP. With approval of the NCSP Manager, the CSSG may also provide technical assistance to other Department of Energy (DOE) and DOE Contractor organizations. Quarterly reports on the status of all tasks shall be provided to the NCSP Manager no later than the last day of the month following the end of the quarter.

LLNL POC: David Heinrichs (925-424-5679)
DOE POC: Jerry McKamy, NNSA (301-903-8031)

Tasks: Analytical Methods, Integral Experiments, Nuclear Data, Training and Education, and the Criticality Safety Support Group
Oak Ridge National Laboratory (ORNL): $4,167K

Funds are provided to ORNL to maintain criticality safety codes, including associated cross-section processing codes; to continue criticality safety related code distribution and user support through Radiation Safety Information Computational Center; to participate in the Critical and Subcritical Experiments Design Team (C_edT) process; to conduct criticality safety related nuclear data acquisition, evaluation, testing, and publication; and to coordinate the design of the future Nuclear Criticality Safety Program (NCSP) Training Program, as delineated in the NCSP Five-Year Plan dated September 2008, or as directed by the NCSP Manager. Funds are also provided for Criticality Safety Support Group (CSSG) technical support to the NCSP Manager regarding planning and execution of the NCSP. With approval of the NCSP Manager, the CSSG may also provide technical assistance to other Department of Energy (DOE) and DOE Contractor organizations. Quarterly reports on the status of all tasks shall be provided to the NCSP Manager no later than the last day of the month following the end of the quarter.

ORNL POC: Cecil Parks (865-574-5280)
DOE POC: Jerry McKamy, NNSA (301-903-8031)

Tasks: Integral Experiments, Training and Education
Sandia National Laboratories (SNL): $305K

Funds are provided to SNL to conduct nuclear criticality integral experiments and training for Criticality Experiments Facility (CEF) operators as delineated in the Nuclear Criticality Safety Program (NCSP) Five-Year Execution Plan dated September 2008, or as directed by the NCSP Manager. Quarterly reports on the status of all tasks shall be provided to the NCSP Manager no later than the last day of the month following the end of the quarter.

SNL POC: Gary Harms (505-845-3244)
DOE POC: Jerry McKamy, NNSA (301-903-8031)

Appendix C
International Criticality Safety Benchmark Evaluation Project
Planned Benchmarks

ICSBEP BENCHMARK PRIORITIES FOR FY 2009		
IDENTIFIER	***DRAFT TITLE***	**JUSTIFICATION**
MIX-COMP-FAST-003	ZPR-3 Assemblies 48 and 48B: A Clean Cylindrical Pu/U/C/Na Cores, Reflected by Depleted Uranium	ZPR-3 Assembly 48 is a CSEWG Benchmark that has traditionally been used to test plutonium data in a slightly softened spectrum. There are known deficiencies in ^{239}Pu and the data may be irretrievable within a few years. Assembly 48B is a variant with increased ^{240}Pu.
PU-COMP-FAST-004	ZPR-3 Assembly 56B: A Clean, Cylindrical Plutonium Oxide Benchmark Assembly Reflected by Nickel	This experiment is a CSEWG Benchmark that has traditionally been used to test plutonium and nickel (important structural material) data in a slightly softened spectrum. There are known deficiencies in both of these nuclides and the data may be irretrievable within a few years.
PU-MET-FAST-047	Investigation of Lead Cross Sections in Fast and Intermediate Neutron Spectra in BFS (IPPE)	The lead cross section has undergone recent improvements as a result of several ICSBEP benchmarks. These experiments provide independent test of lead transport, capture, and inelastic scatter cross sections while lead is undergoing improvements.
SUB-PU-MET-FAST-003	Nickel-Reflected Plutonium Metal Sphere Subcritical Noise Measurements	This experiment is a new CEF measurement. There are known deficiencies in Ni.
SUB-PU-MET-FAST-002	Acrylic-Reflected Plutonium Metal Sphere Subcritical Noise Measurements	This experiment is a new CEF measurement. Only a small amount of data on Acrylic is currently available.
HEU-MET-FAST-043	VNIITF Fe/HEU Cylindrical Configurations (Experiments 2017-2019, 2021, 2022, 3010, 4006, 4012) and CH_2 Moderated/Reflected Base Case (4002)	These experiments test the iron cross section and fill a gap in ICSBEP database. The data are needed for spent fuel shipping/disposal container analyses and are expected to be high-fidelity benchmarks.
HEU-MET-THERM-028	SPADE – BeO Moderated Oy Experiments with Special Materials — Part 1: Tungsten, Tantalum, and Gold	Special materials (Tungsten, Tantalum and Gold) for which there is little on no data in the ICSBEP database will be systematically selected from the large SPADE series of integral experiments that test nuclear cross sections of these materials. Tungsten is included to coincide with new VNIITF results and provide independent tests of the tungsten cross sections.

ICSBEP BENCHMARK PRIORITIES FOR FY 2010		
IDENTIFIER	***DRAFT TITLE***	**JUSTIFICATION**
IEU-MET-FAST-015	ZPR-3 Assembly 6F: A Clean Cylindrical Core with a ^{235}U-to-^{238}U Ratio of 1, Reflected by Depleted Uranium	This experiment is a CSEWG Benchmark that has a unique ^{235}U-to-^{238}U Ratio and helps fill the gap in intermediate enriched systems. These data may be irretrievable within a few years.
IEU-COMP-FAST-004	ZPR-3 Assembly 12: A Large, Clean, Cylindrical Uranium (21% ^{235}U)Carbide Benchmark Assembly Reflected by Depleted Uranium	This experiment is a CSEWG Benchmark that simulates a ^{235}U enrichment of 21% and helps fill the gap in intermediate enriched systems. These data may be irretrievable within a few years.
HEU-MET-THERM-029	SPADE – BeO Moderated Oy Experiments with Special Materials — Part 2: TBD	Special materials (TBD) for which there is little on no data in the ICSBEP database will be systematically selected from the large SPADE series of integral experiments that test nuclear cross sections of these materials.
HEU-MET-INTER-010	ORNL HEU Metal Annuli filled with Be	There are known deficiencies in the beryllium cross section. This series of experiments is expected to provide and excellent test of beryllium and should contribute significantly to the improvement of the Be cross section.
SUB-PU-MET-FAST-006	Lead-Reflected Plutonium Metal Sphere Subcritical Noise Measurements	This experiment is a new CEF measurement and has been moved up in priority to complete the set of integral data for lead. Timely performance and evaluation of these data will enable cross-section evaluators to work with all available data in an effort to resolve known deficiencies in Pb.
SUB-PU-MET-FAST-005	Tungsten-Reflected Plutonium Metal Sphere Subcritical Noise Measurements	This experiment is a new CEF measurement that will complement the new tungsten data that are being generated at VNIITF during FY 2009. Timely performance and evaluation of these data will enable cross-section evaluators to work with all available data in an effort to resolve known deficiencies in W.
HEU-MET-FAST-044	VNIITF Al/HEU Cylindrical Configurations (Experiments 2023-2027, 3005, 4008, 4014)	These experiments test the aluminum cross section. The data are needed for spent fuel shipping/disposal container analyses and are expected to be high-fidelity benchmarks. (Check Sensitivity)

ICSBEP BENCHMARK PRIORITIES FOR FY 2011		
IDENTIFIER	***DRAFT TITLE***	**JUSTIFICATION**
IEU-COMP-FAST-005	ZPR-3 Assembly 11: A Large, Clean, Cylindrical Uranium (12% ^{235}U) Carbide Benchmark Assembly Reflected by Depleted Uranium	This experiment is a CSEWG Benchmark that simulates a ^{235}U enrichment of 12% with a slightly softened spectrum and helps fill the gap in intermediate enriched systems. These data may be irretrievable within a few years.
PU-COMP-FAST-005	ZPR-3 Assembly 53: A Clean Cylindrical Pu Carbide Core, Reflected by DU	ZPR-3 Assembly 53 is a high-fidelity benchmark that serves as the reference case for Assembly 54. These data may be irretrievable within a few years.
PU-COMP-FAST-006	ZPR-3 Assembly 54: A Clean Cylindrical Pu Carbide Core, Reflected by Iron	This experiment provides unique, high-fidelity data for iron as a reflector and the data may be irretrievable within a few years.
HEU-MET-THERM-004	SPADE – BeO Moderated Oy Experiments with Special Materials — Part 3: TBD	Special materials (TBD) for which there is little on no data in the ICSBEP database will be systematically selected from the large SPADE series of integral experiments that test nuclear cross sections of these materials.
SUB-PU-MET-FAST-004	Copper-Reflected Plutonium Metal Sphere Subcritical Noise Measurements	This experiment is a new CEF measurement. Since the ZEUS assembly utilizes a thick copper reflector, it is important to clearly understand the nuclear properties of copper.
SUB-PU-MET-FAST-007	Manganese-Reflected Plutonium Metal Sphere Subcritical Noise Measurements	This experiment is a new CEF measurement. Manganese is an important structural material with known deficiencies. (Verify Relevance in the fast regime)
HEU-MET-MIXED-013	SNOOPY Experiments -- Graphite Moderated HEU Foils – Part II (C/U = 1200)	This experiment provides data for a unique carbon-to-uranium ratio.

ICSBEP BENCHMARK PRIORITIES FOR FY 2012		
IDENTIFIER	***DRAFT TITLE***	**JUSTIFICATION**
HEU-MET-FAST-045	Borabond Experiment	This experiment is a new CEF measurement and fills a gap in the ICSBEP database for Borabond and satisfies a specific user need.
HEU-MET-TBD-TBD	HEU Spherical Lattice	This experiment is a new CEF measurement and fills a gap in the ICSBEP database for the combination of materials and geometry and satisfies a specific user need.
HEU-COMP-FAST-004	ZPR-3 Assembly 14: A Clean HEU (93% ^{235}U) Carbide Core Reflected by Depleted Uranium	This experiment provides a test of ^{235}U in a slightly softened spectrum. These data may be irretrievable within a few years.
IEU-COMP-FAST-003	ZPR-6 Assembly 5: A Large, Clean, Cylindrical Uranium Carbide Benchmark Assembly Reflected by Depleted Uranium	This experiment is a CSEWG Benchmark that has traditionally been used to test plutonium data in a slightly softened spectrum. These data may be irretrievable within a few years.
HEU-TBD-TBD	Y-DR-83 polyethylene-reflected 8-unit array experiments with HEU separated by plywood, celotex, foamglas, and borated plastic foam.	These experiments provide data for a unique set of important materials used in transportation and storage containers.
HEU-MET-THERM-017	SPADE – BeO Moderated Oy Experiments with Special Materials — Part 4: TBD	Special materials (TBD) for which there is little on no data in the ICSBEP database will be systematically selected from the large SPADE series of integral experiments that test nuclear cross sections of these materials.
HEU-MET-THERM-030	SNOOPY Experiments -- Graphite Moderated HEU Foils – Part III(C/U = 2340)	This experiment provides data for a unique carbon-to-uranium ratio.

ICSBEP BENCHMARK PRIORITIES FOR FY 2013		
IDENTIFIER	***DRAFT TITLE***	**JUSTIFICATION**
HEU-MET-FAST-046	HEU / Vanadium Critical Experiments	This experiment is a new CEF measurement that will complement the new vanadium data that were generated at VNIITF during FY 2008. Timely performance and evaluation of these data will enable cross-section evaluators to work with all available data in an effort to establish the accuracy and, if necessary, improve the V cross sections.
TBD	Flattop Gap Experiments	This experiment is a new CEF measurement that will challenge current ability to calculate the effects of significant streaming paths.
PU-COMP-FAST-003	ZPR-9 Assembly 31: Plutonium Carbide Benchmark Assembly Reflected by DU	This experiment is a CSEWG Benchmark that has traditionally been used to test plutonium data in a slightly softened spectrum. These data may be irretrievable within a few years.
IEU-MET-FAST-011	ZPR6-1 All Aluminum - 14% Enriched	This experiment provides high-fidelity benchmark data that simulates a unique uranium enrichment of %14. These data may be irretrievable within a few years.
HEU-TBD	Y-DR-109 concrete reflected arrays of HEU and polyethylene reflected arrays of HEU separated by vermiculite	These experiments provide data for a unique set of important materials used in transportation and storage containers.
HEU-MET-THERM-019	SPADE – BeO Moderated Oy Experiments with Special Materials — Part 5: TBD	Special materials (TBD) for which there is little on no data in the ICSBEP database will be systematically selected from the large SPADE series of integral experiments that test nuclear cross sections of these materials.
IEU-MET-THERM-001	Cronin U(37.5) Metal Experiments, Recently Unclassified	These experiments provide unique intermediate enriched data. The experimenter is no longer available and those familiar with the experiments may no longer be available within a few years.

Appendix D
Nuclear Data

Differential Measurements – Elements

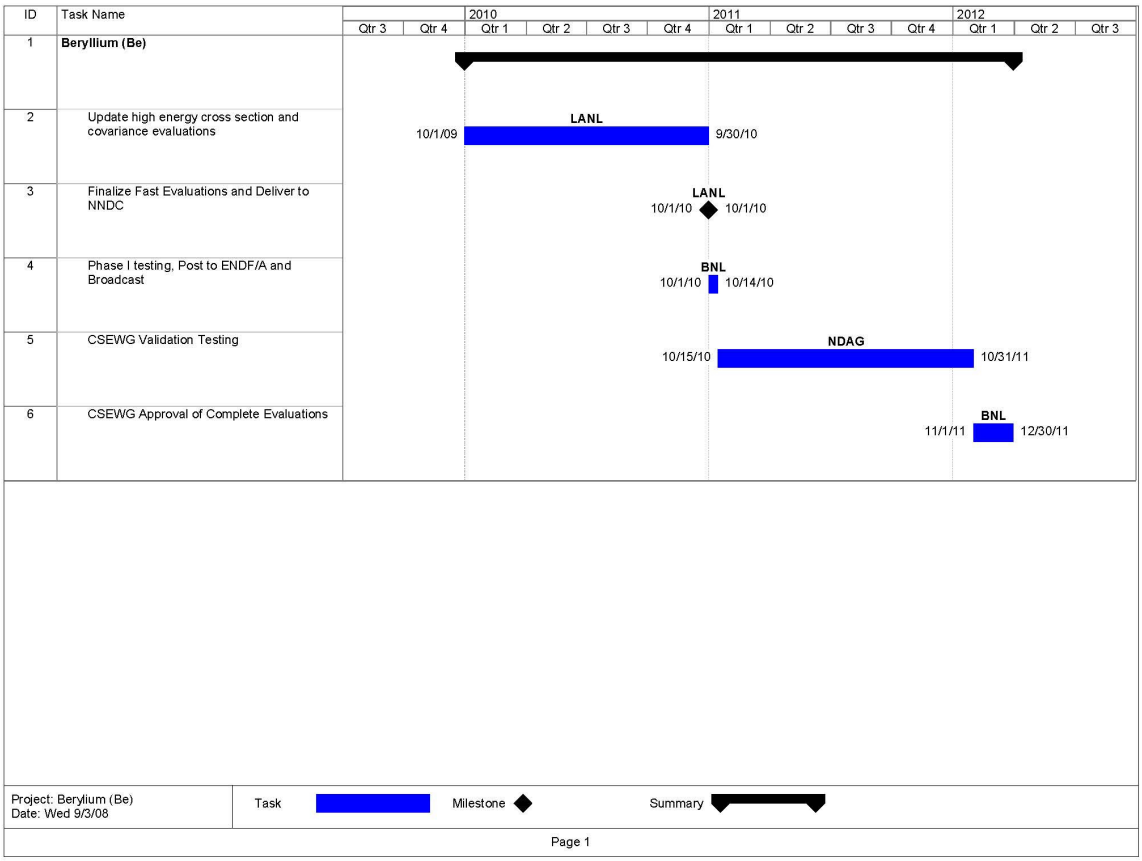
Calcium (Ca)	D-1.2
Cerium (Ce)	D-1.3
Chromium (Cr-50, 52, 53, 54)	D-1.4
Copper (Cu-63, 65)	D-1.5
Dysprosium (Dy)	D-1.6
Fluorine (F-19)	D-1.7
Gadolinium (Gd)	D-1.8
Manganese (Mn-55)	D-1.9
Neptunium (Np-237)	D-1.10
Nickel (Ni-58, 60, 61, 62, 64)	D-1.11
Oxygen (O-16)	D-1.12
Plutonium (Pu-239)	D-1.13
Plutonium (Pu-240)	D-1.14
Potassium (K-39, 40, 41)	D-1.15
Titanium (Ti-46, 47, 48, 49, 50)	D-1.16
Tungsten (W-182, 186)	D-1.17
Uranium (U-235)	D-1.18
Uranium (U-238)	D-1.19
Vanadium (V-51)	D-1.20

Differential Measurements – Compounds	D-2
Silicon Dioxide (SiO_2)	D-2.1
Integral Measurements – Sub Critical	D-3
Plutonium Reflected by Copper (Cu) (or Lead)	D-3.1
Plutonium Reflected by Lead (Pb) (or Copper)	D-3.2
Plutonium Reflected by Lucite	D-3.3
Plutonium Reflected by Manganese (Mn)	D-3.4
Plutonium Reflected by Nickel (Ni)	D-3.5
Plutonium Reflected by Polyethylene	D-3.6
Plutonium Reflected by Tungsten (W)	D-3.7
Integral Measurements – Critical	D-4
Borabond	D-4.1
Flattop Gap Experiment	D-4.2
HEU Spherical Lattice	D-4.3
Vanadium HEU Plates	D-4.4
Cross-Section Data Assessments (all on one chart)	D-5

Rhenium (Re-185, 187)
Iron (Fe-56)
Zirconium (Zr)
Hafnium (Hf)
Lanthanum (La)
Neodymium (Nd)
Strontium (Sr)

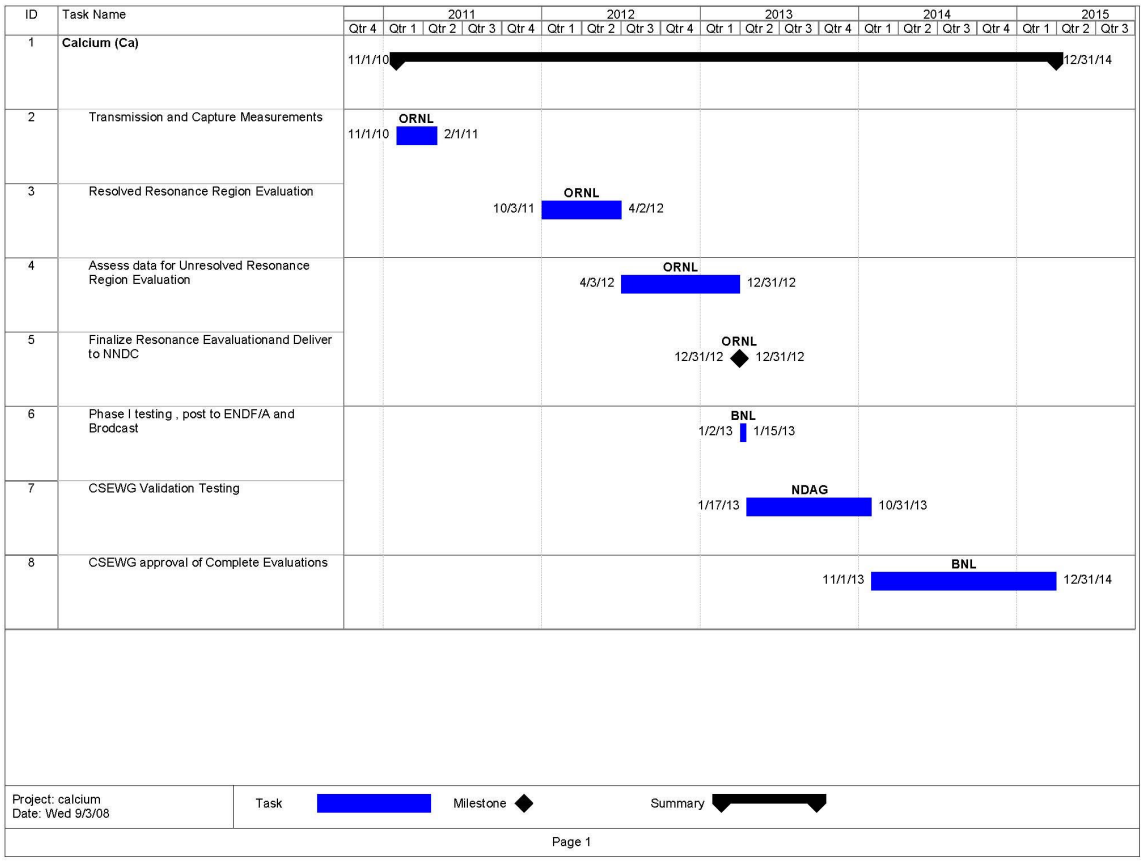
D-1 Differential Measurements – Elements

D-1.1 Beryllium (Be)



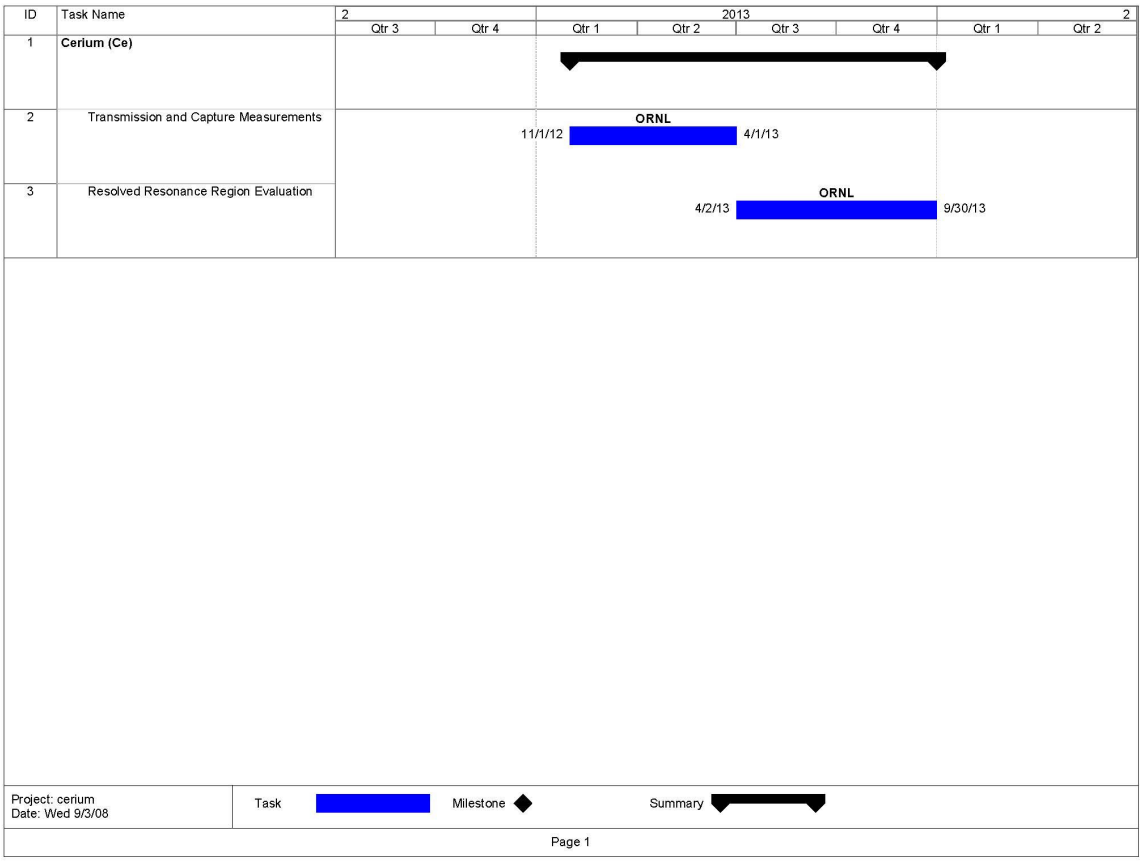
D-1 Differential Measurements – Elements

D-1.2 Calcium (Ca)



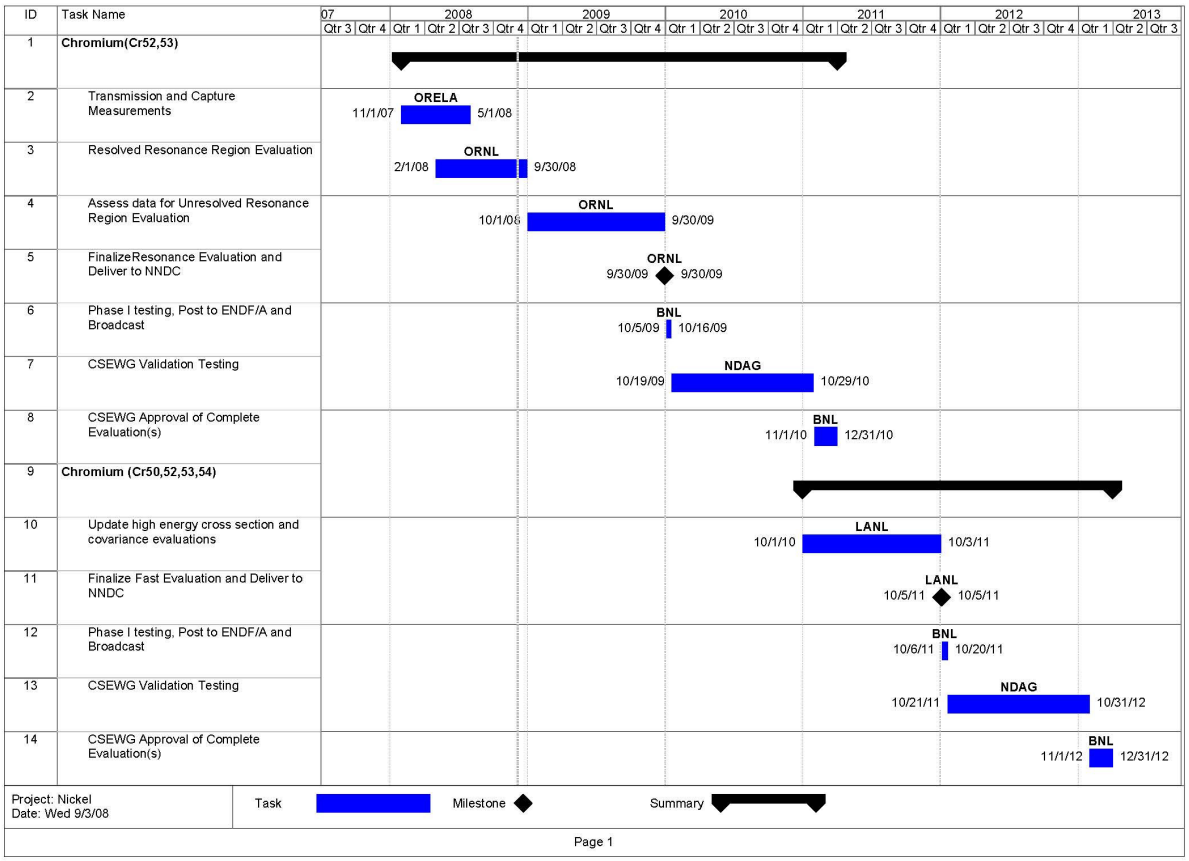
D-1 Differential Measurements – Elements

D-1.3 Cerium (Ce)



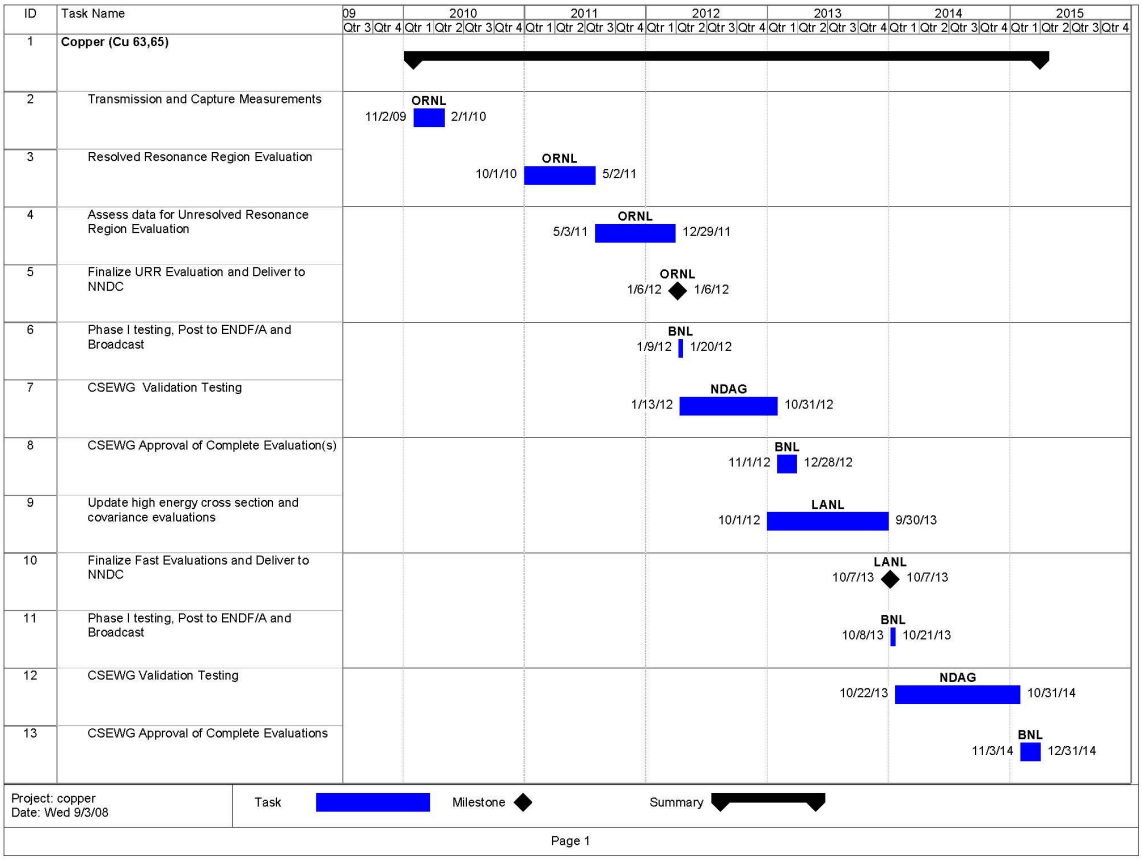
D-1 Differential Measurements – Elements

D-1.4 Chromium (Cr-50, 52, 53, 54)



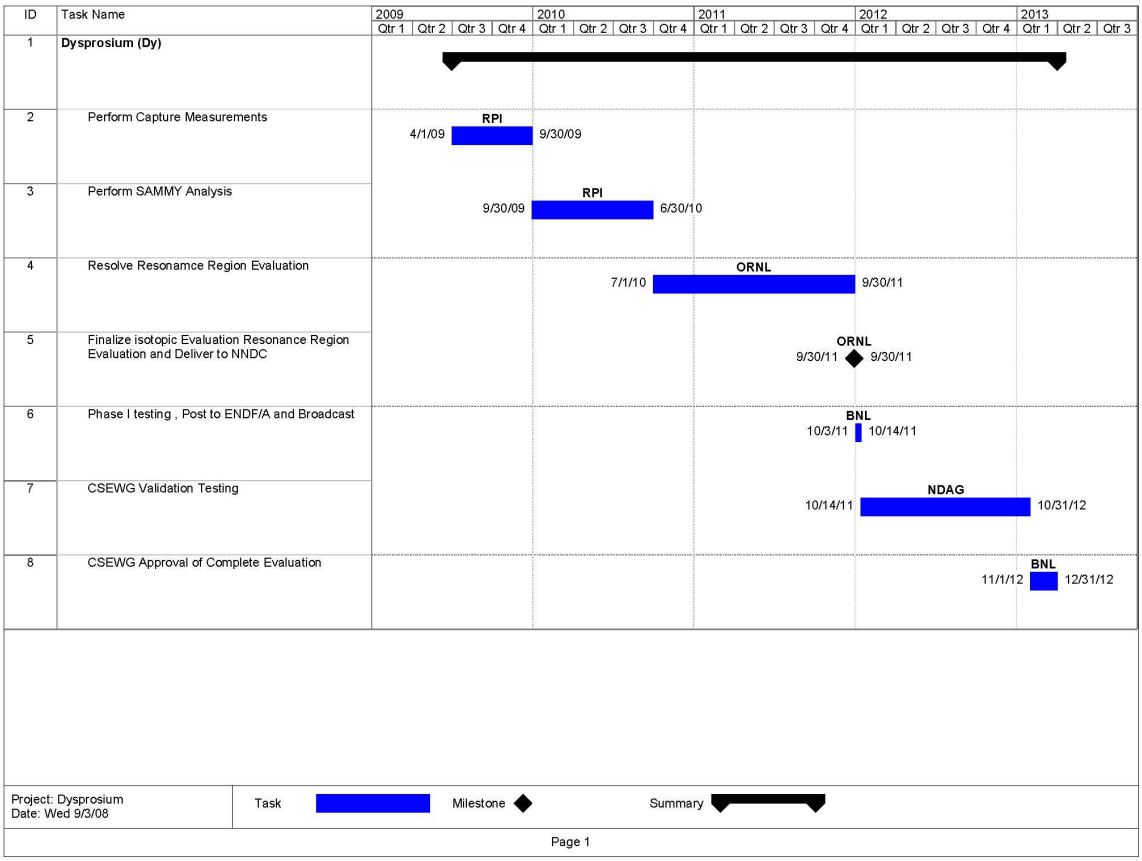
D-1 Differential Measurements – Elements

D-1.5 Copper (Cu-63, 65)



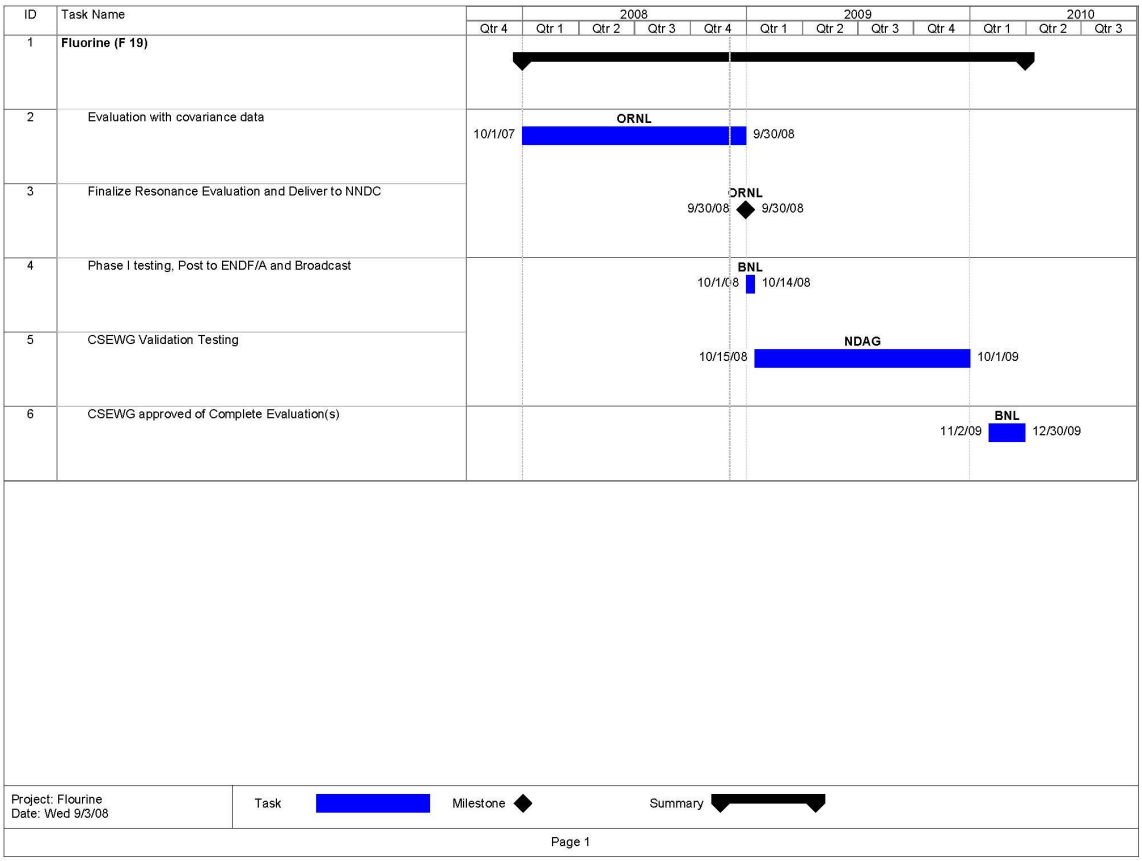
D-1 Differential Measurements – Elements

D-1.6 Dysprosium (Dy)



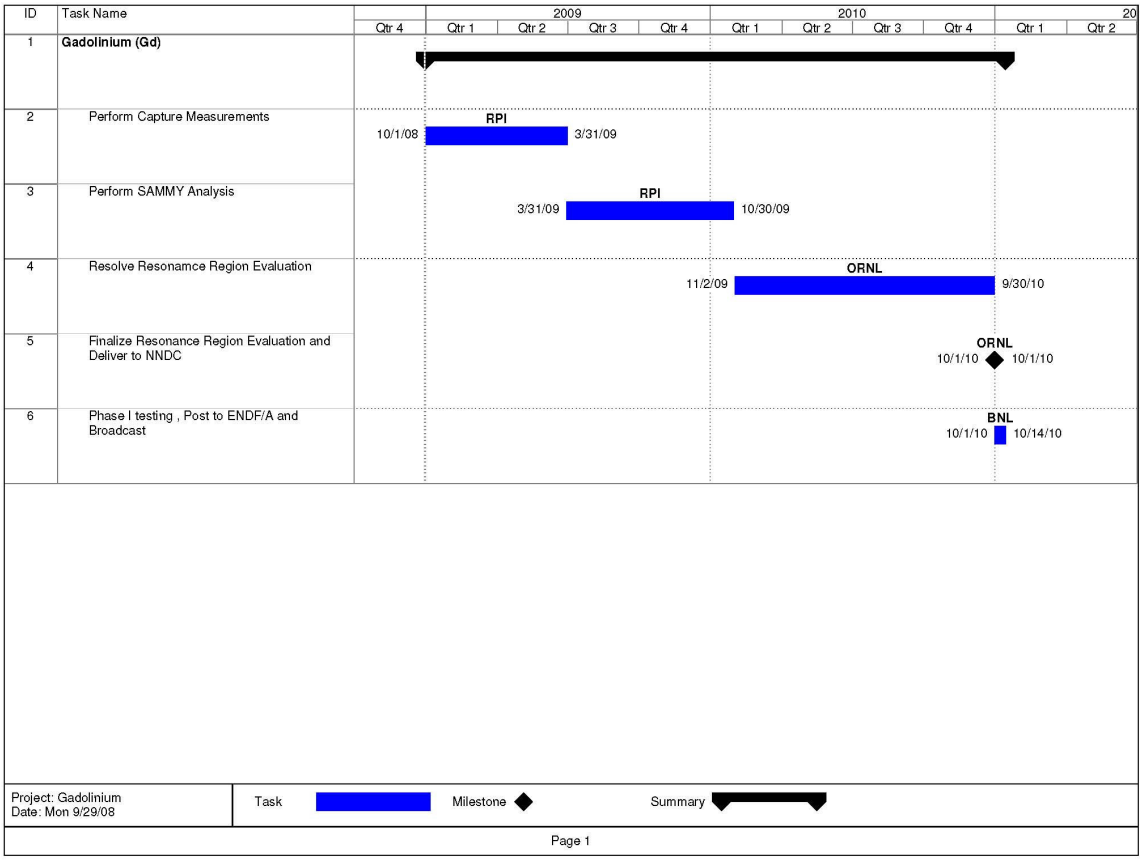
D-1 Differential Measurements – Elements

D-1.7 Fluorine (F-19)



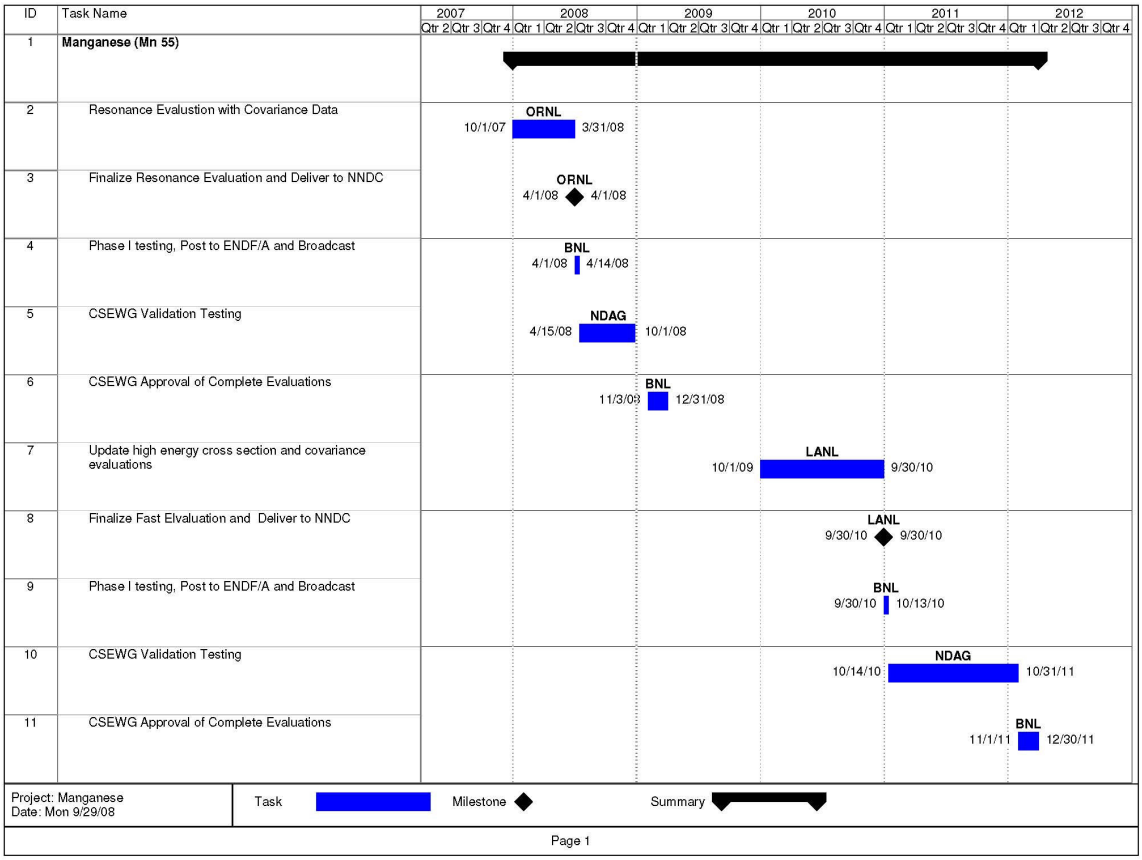
D-1 Differential Measurements – Elements

D-1.8 Gadolinium (Gd)



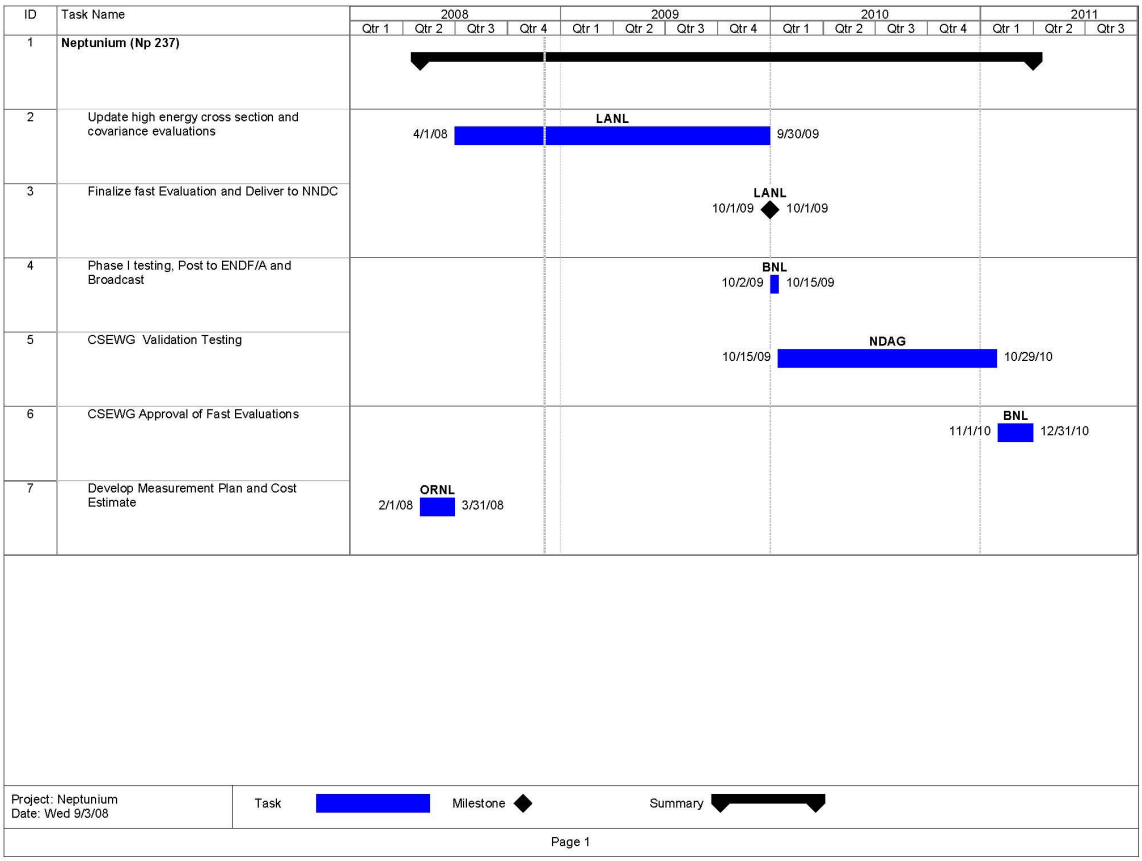
D-1 Differential Measurements – Elements

D-1.9 Manganese (Mn-55)



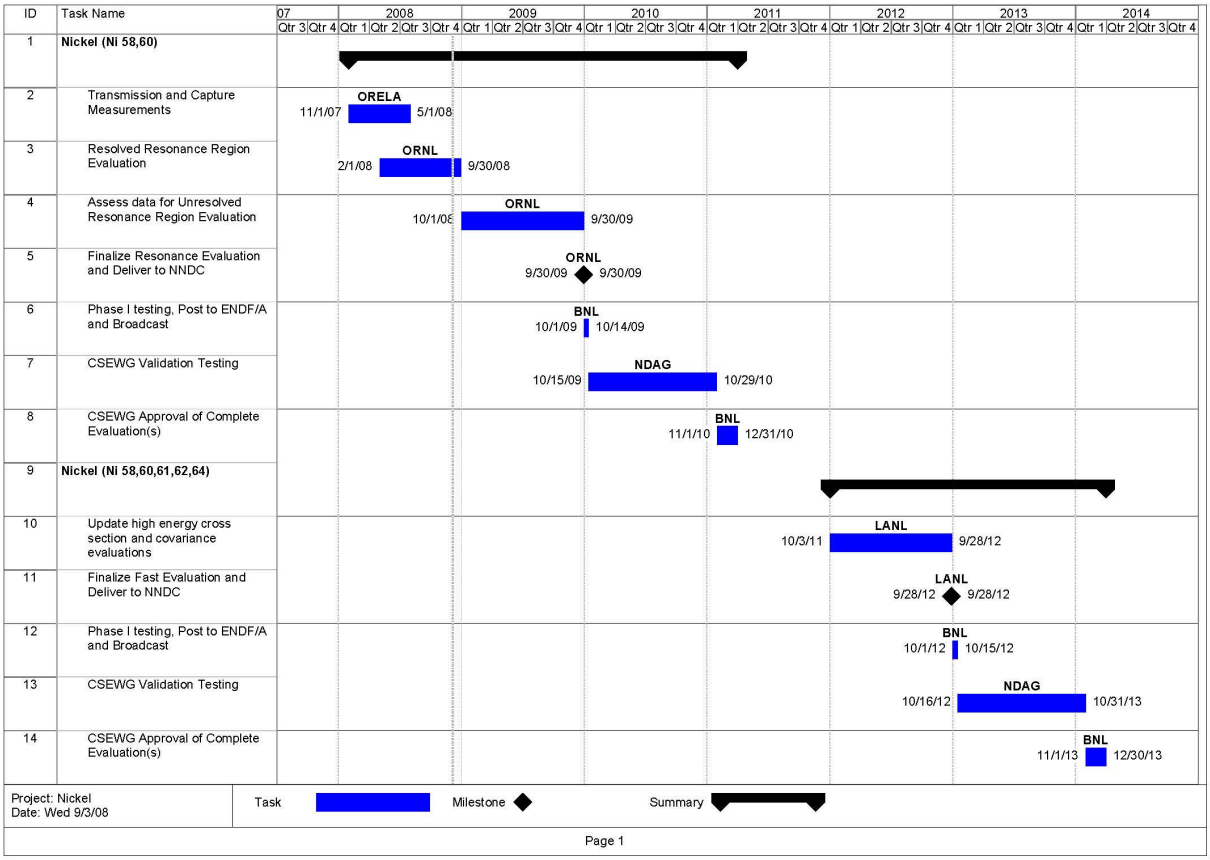
D-1 Differential Measurements – Elements

D-1.10 Neptunium (Np-237)



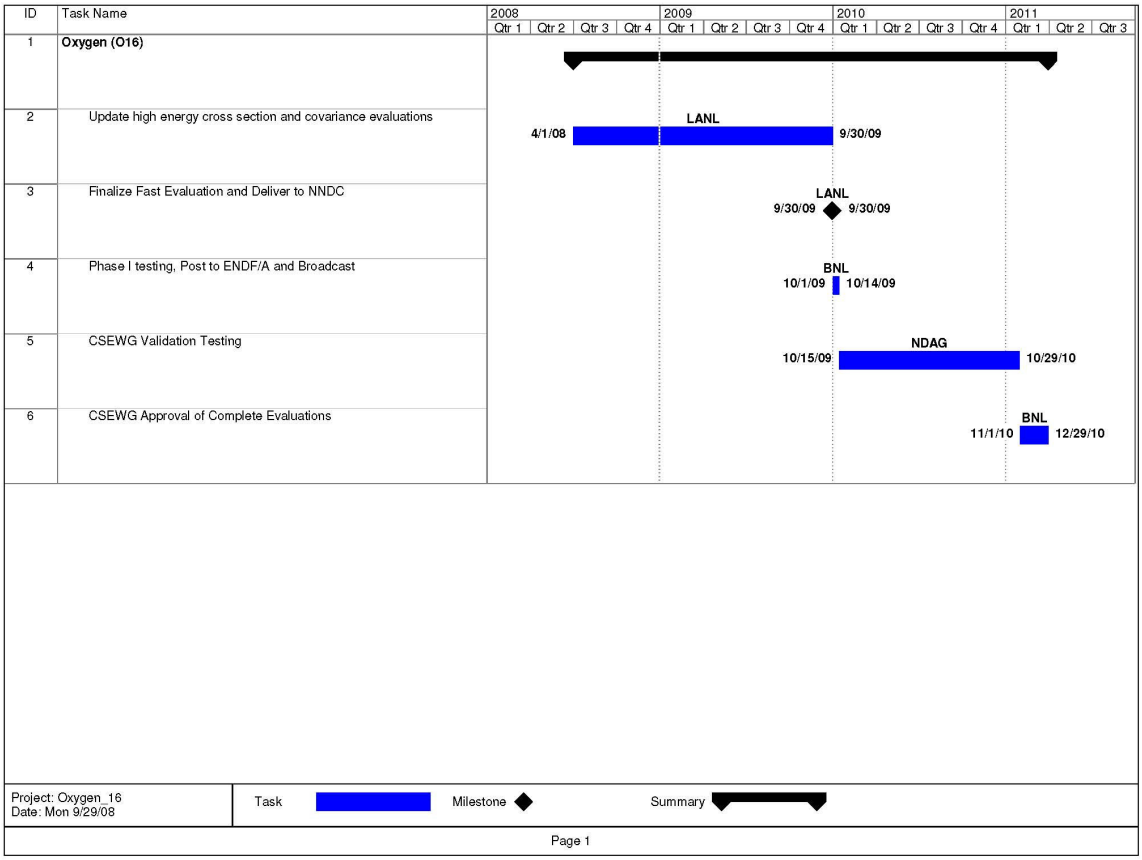
D-1 Differential Measurements – Elements

D-1.11 Nickel (Ni-58, 60, 61, 62, 64)



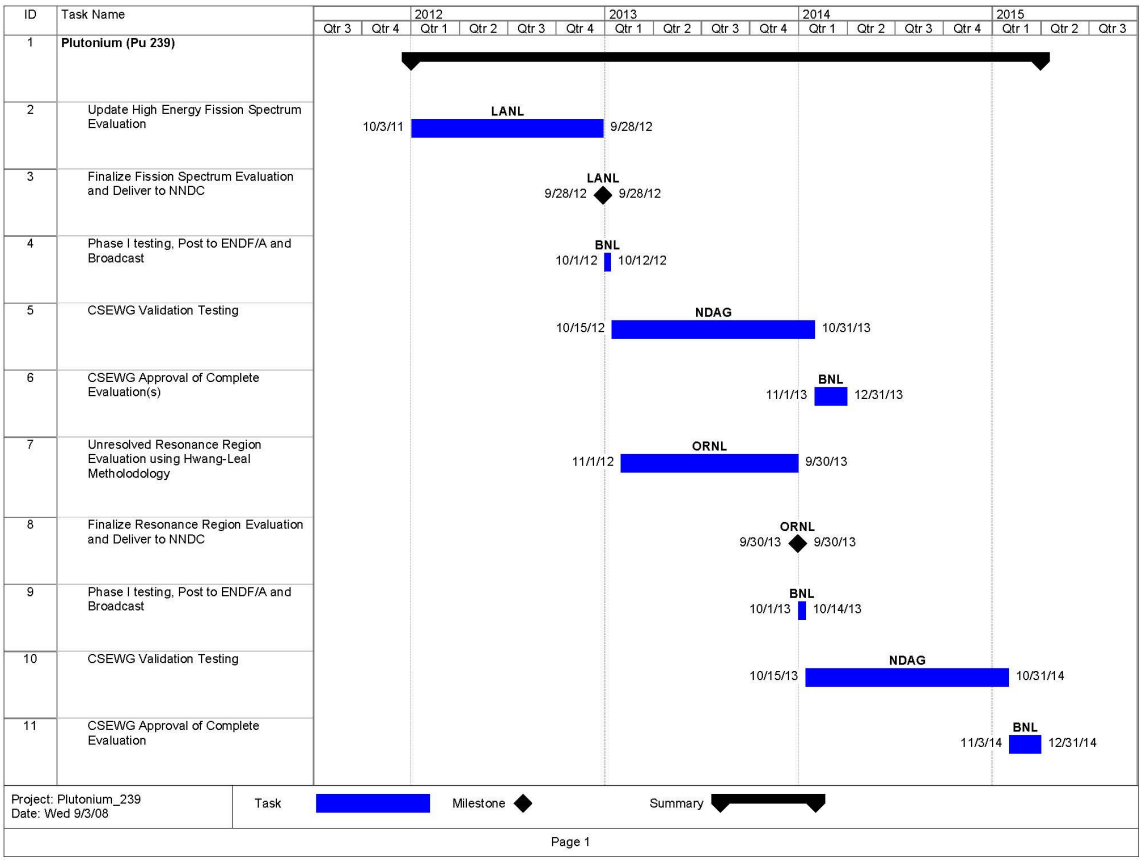
D-1 Differential Measurements – Elements

D-1.12 Oxygen (O-16)



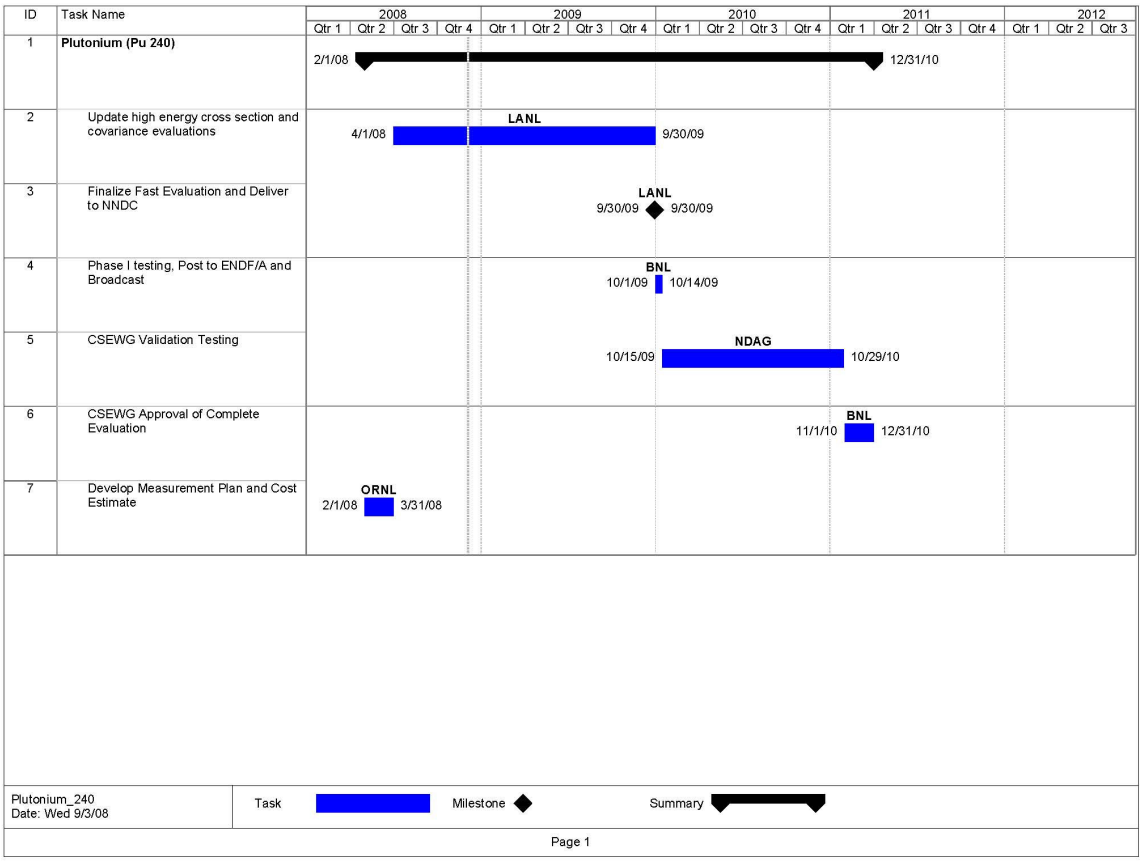
D-1 Differential Measurements – Elements

D-1.13 Plutonium (Pu-239)



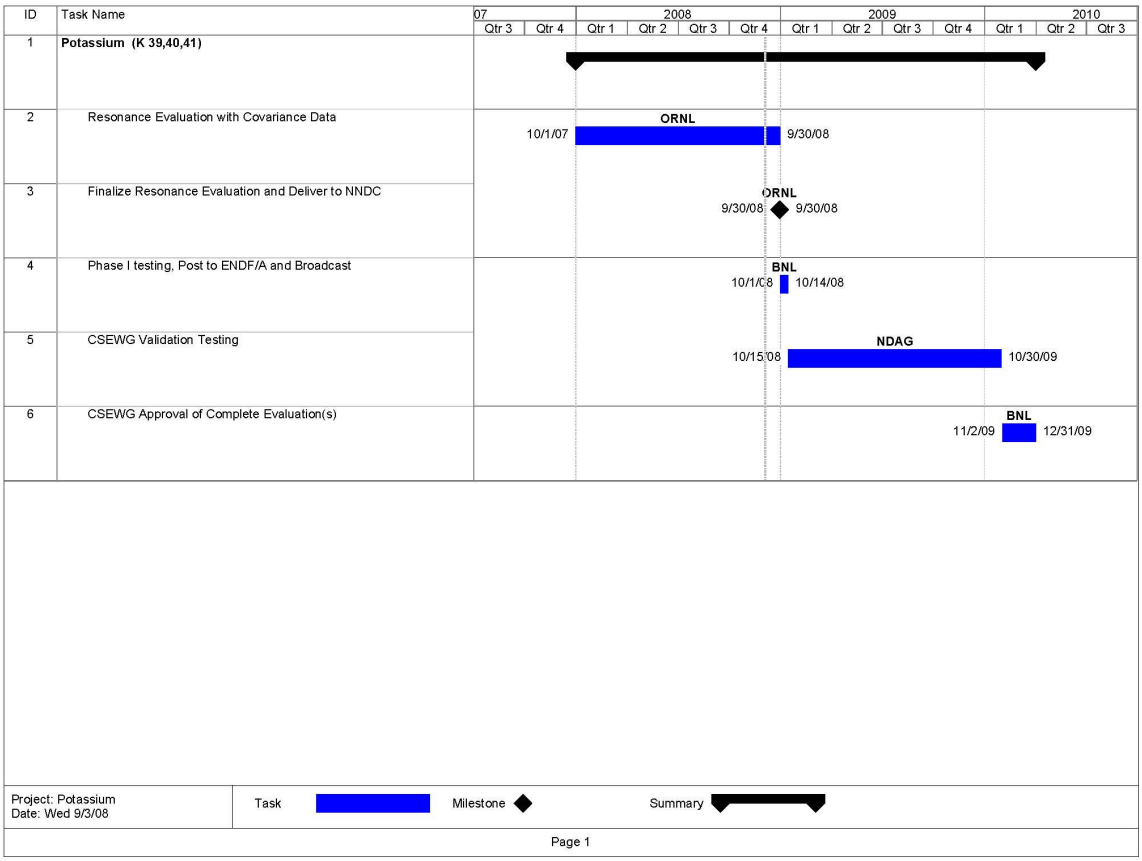
D-1 Differential Measurements – Elements

D-1.14 Plutonium (Pu-240)



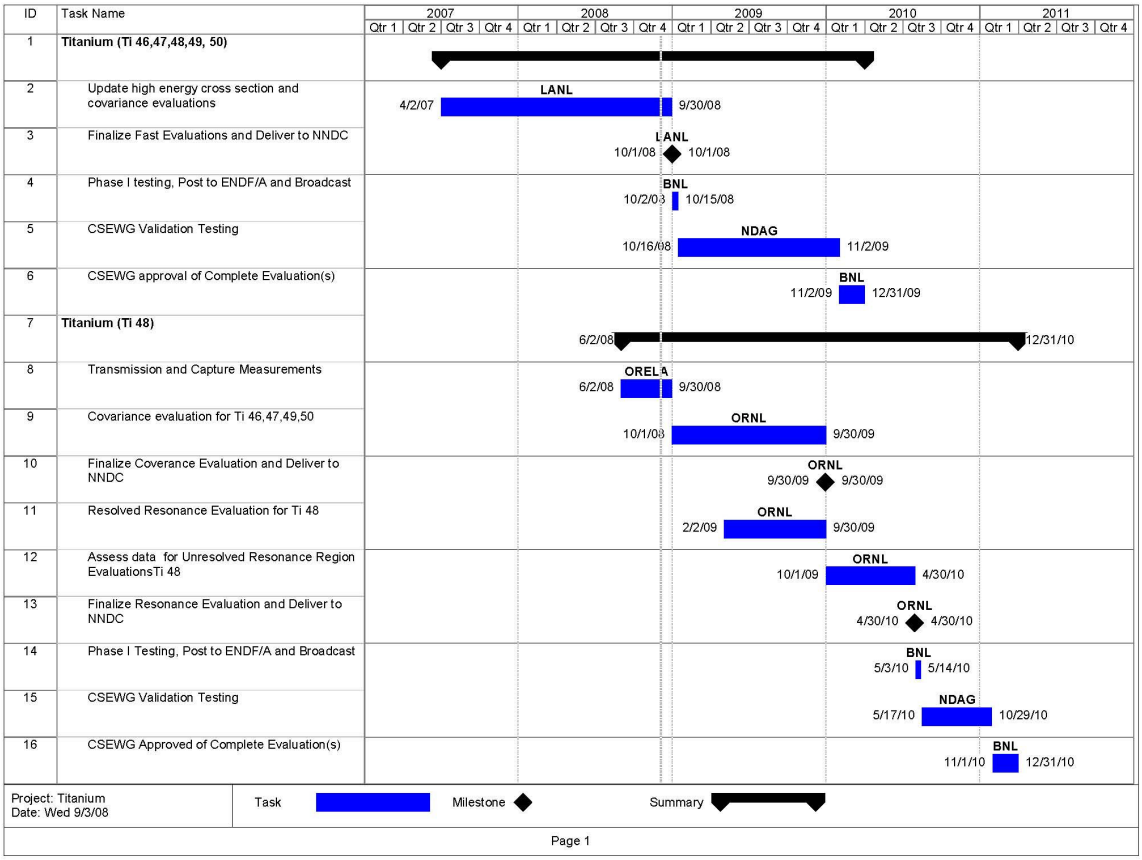
D-1 Differential Measurements – Elements

D-1.15 Potassium (K-39, 40, 41)



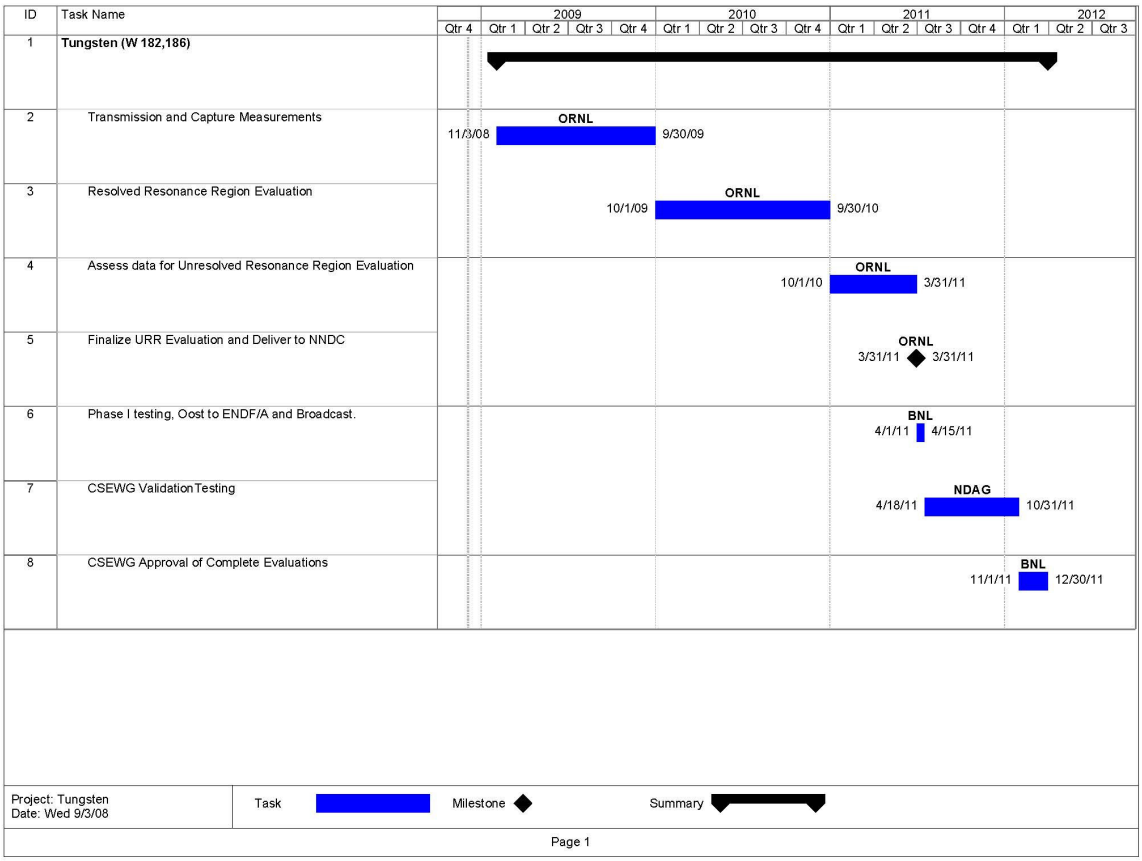
D-1 Differential Measurements – Elements

D-1.16 Titanium (Ti-46, 47, 48, 49, 50)



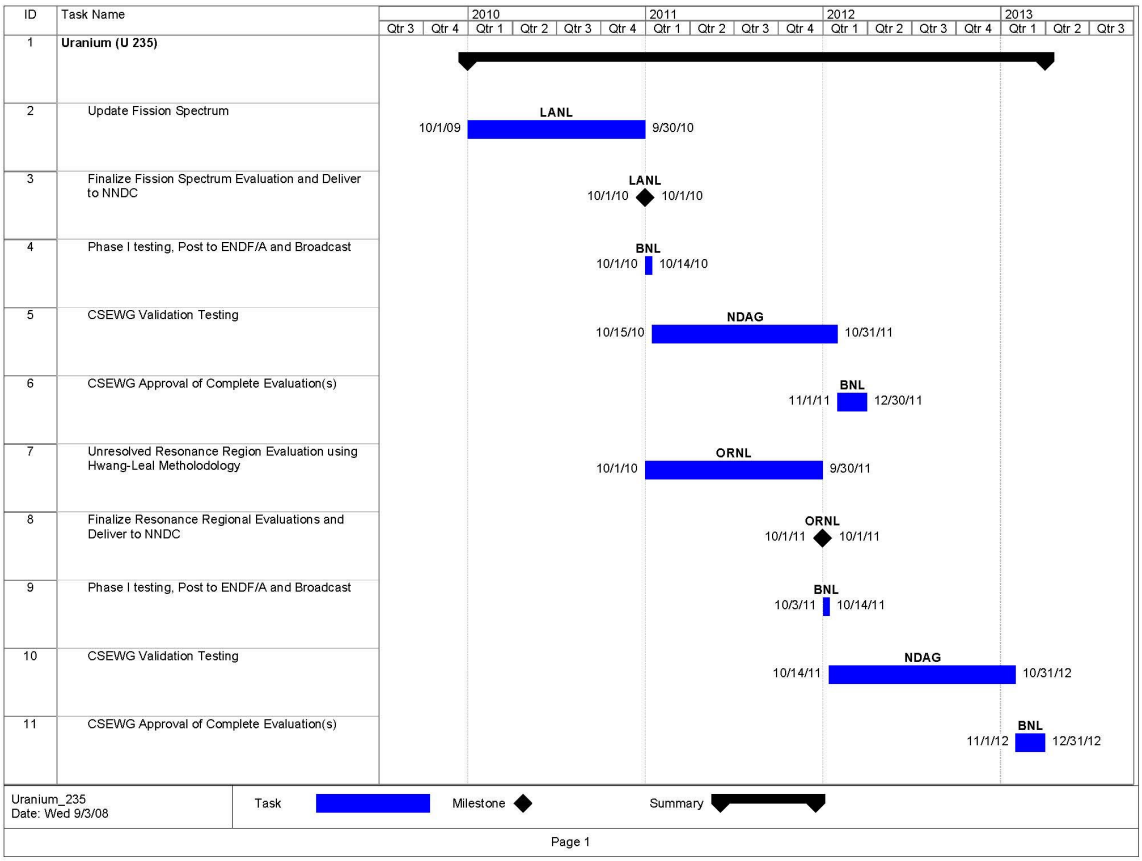
D-1 Differential Measurements – Elements

D-1.17 Tungsten (W-182, 186)



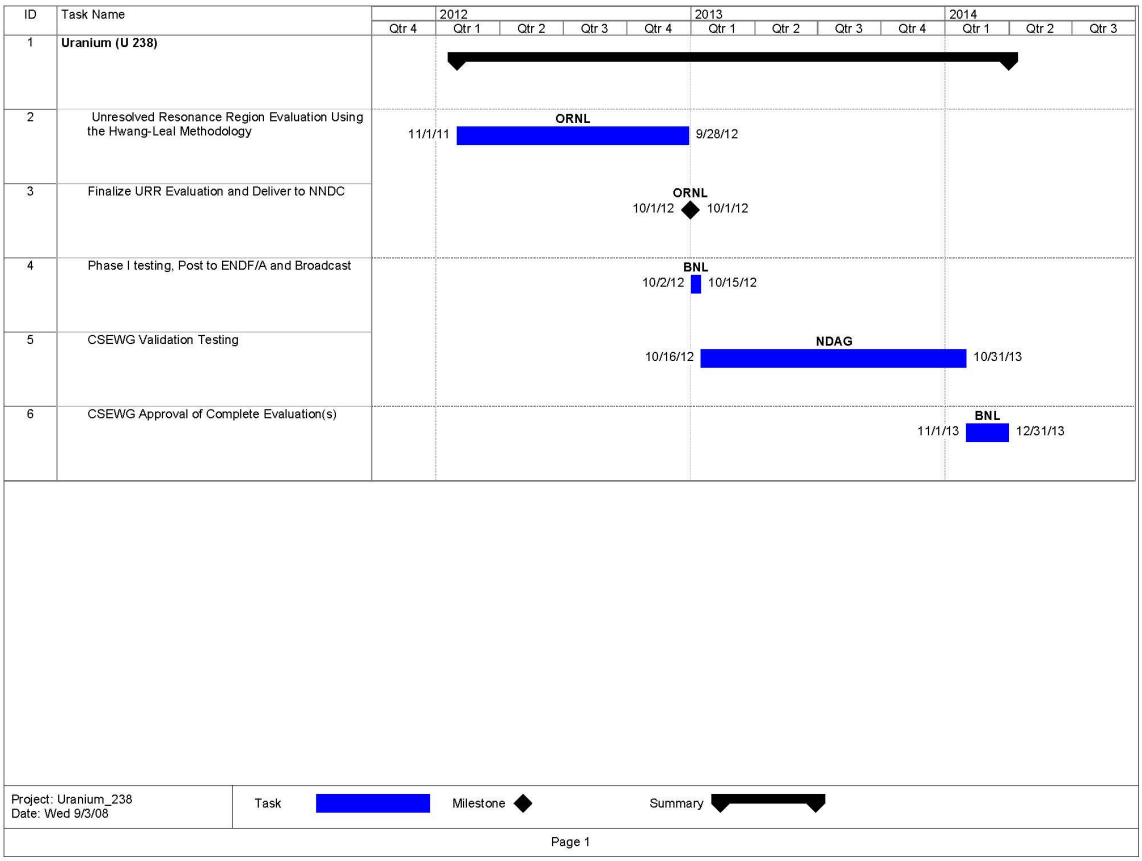
D-1 Differential Measurements – Elements

D-1.18 Uranium (U-235)



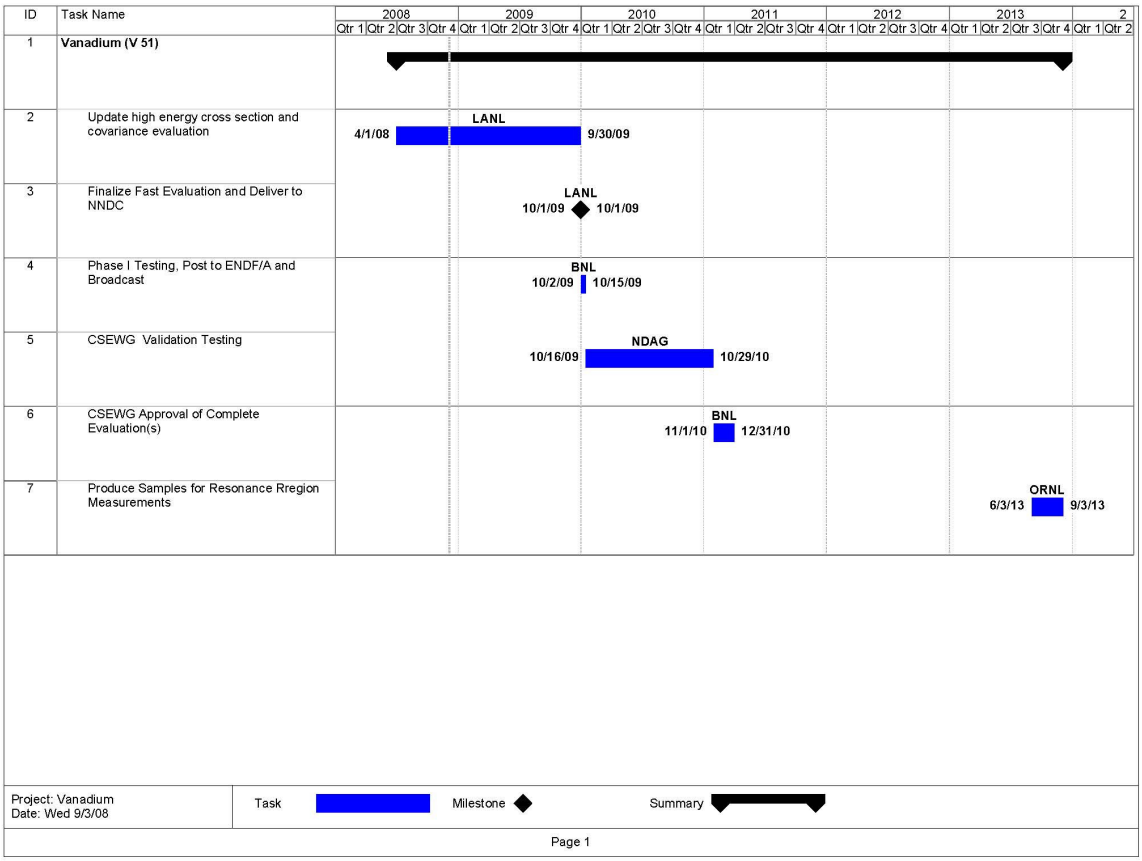
D-1 Differential Measurements – Elements

D-1.19 Uranium (U-238)



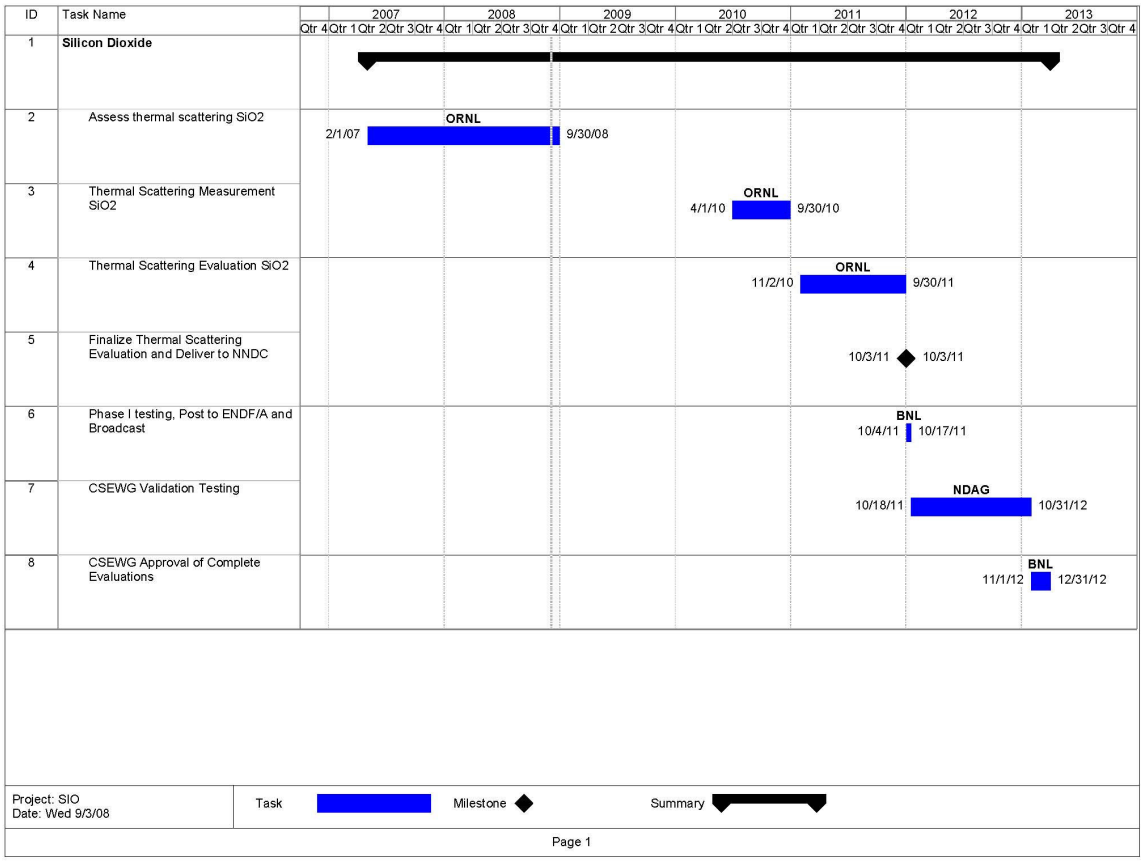
D-1 Differential Measurements – Elements

D-1.20 Vanadium (V-51)



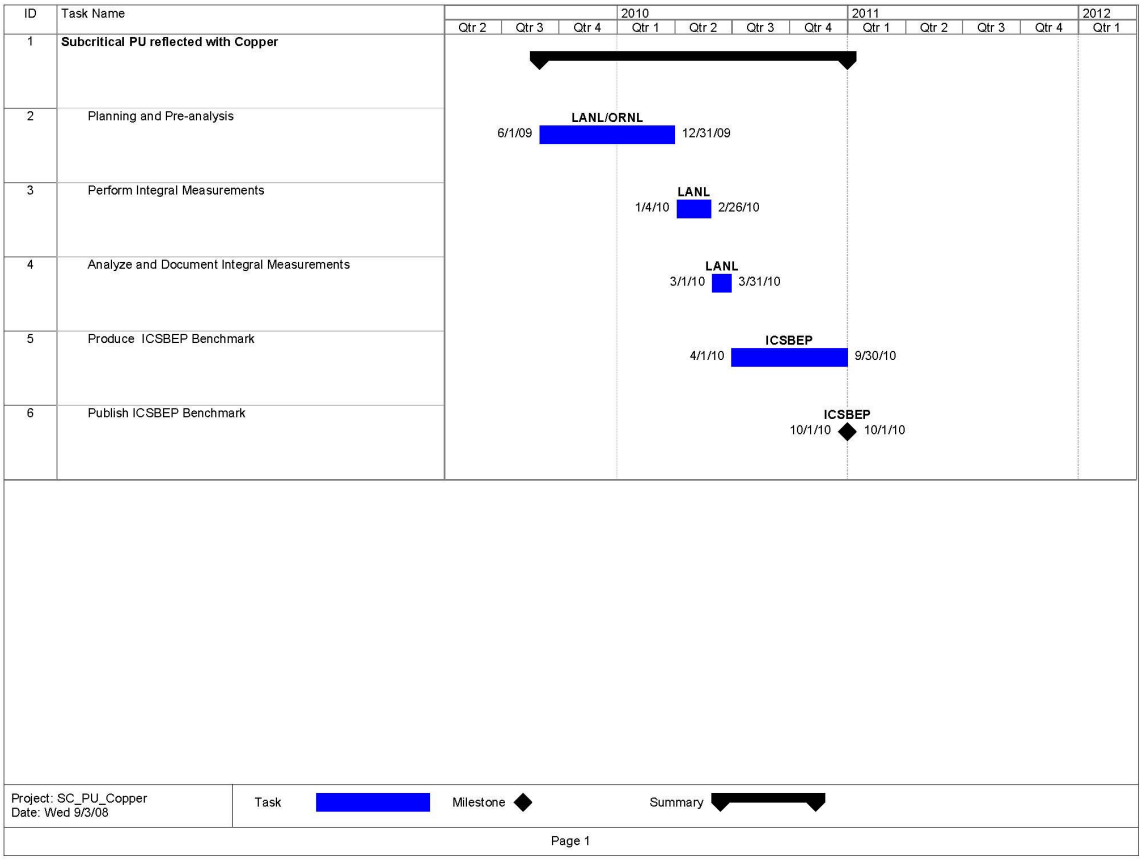
D-2 Differential Measurements – Compounds

D-2.1 Silicon Dioxide (SiO_2)



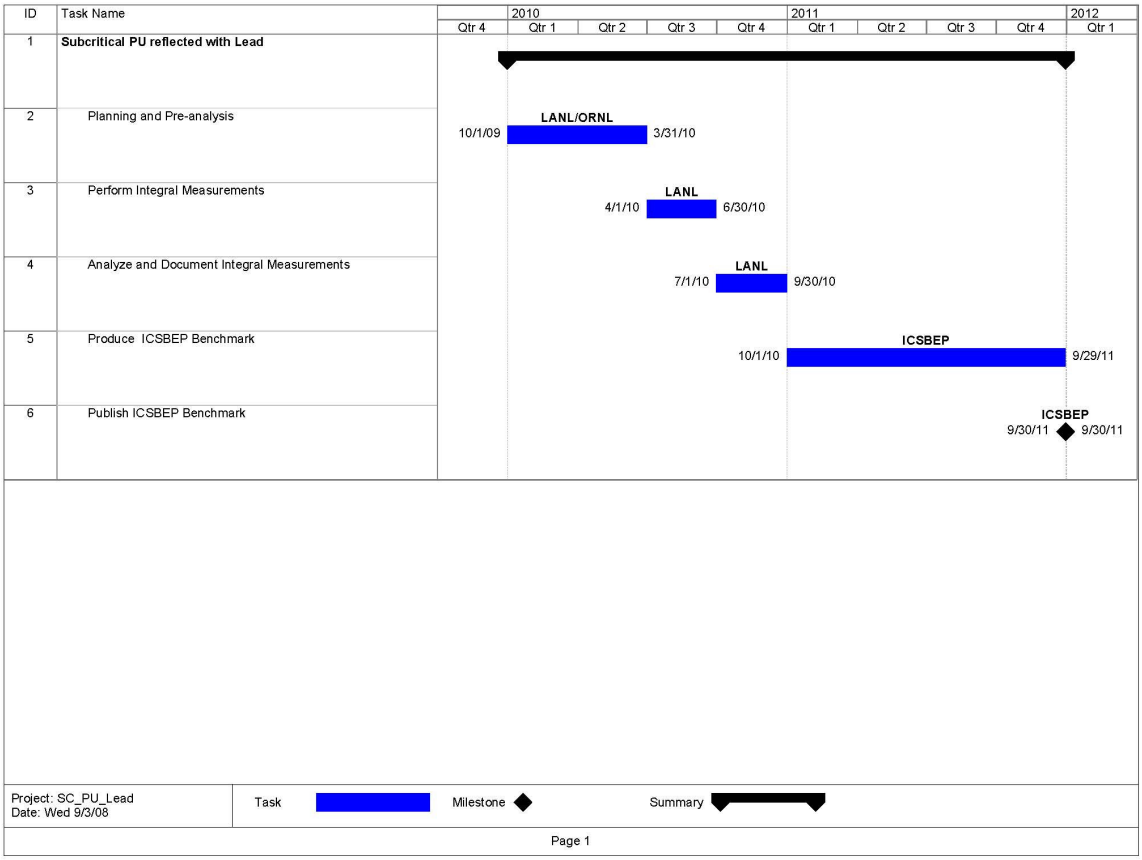
D-3 Integral Measurements – Sub Critical

D-3.1 Plutonium Reflected by Copper (Cu) (or Lead)



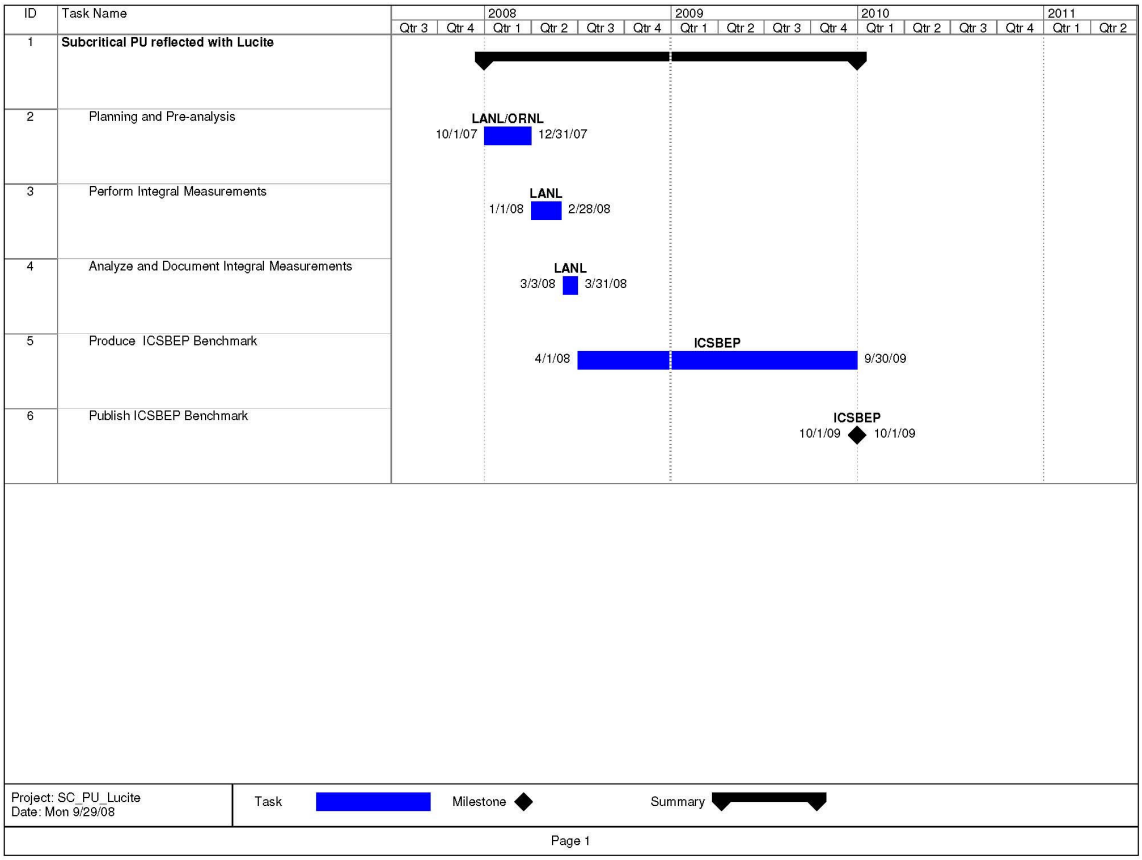
D-3 Integral Measurements – Sub Critical

D-3.2 Plutonium Reflected by Lead (Pb) (or Copper)



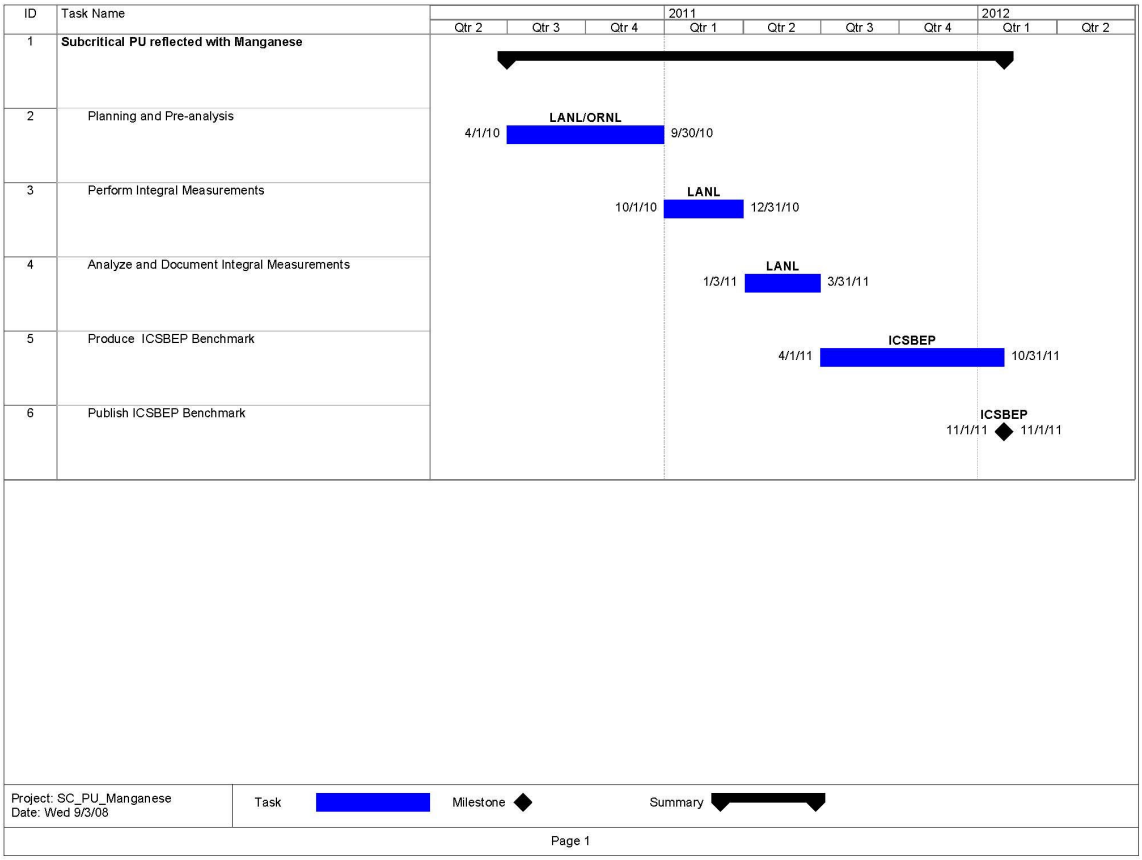
D-3 Integral Measurements – Sub Critical

D-3.3 Plutonium Reflected by Lucite



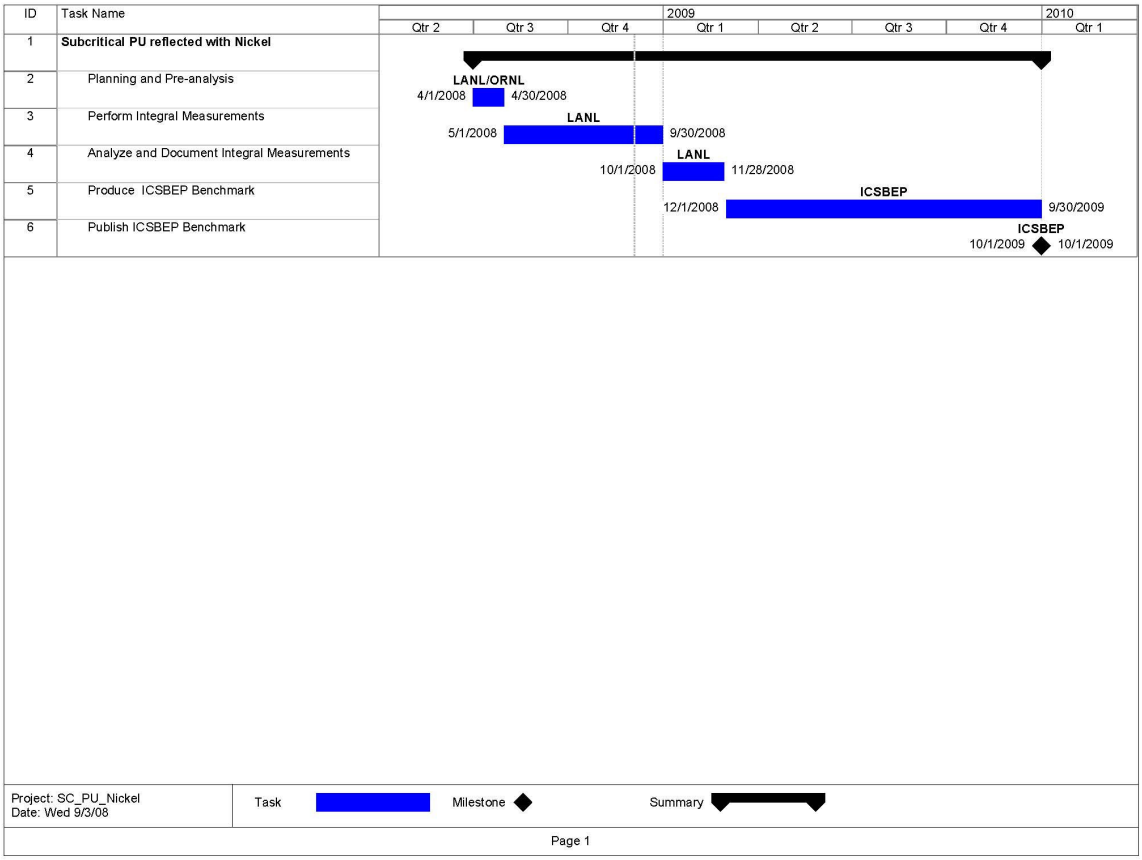
D-3 Integral Measurements – Sub Critical

D-3.4 Plutonium Reflected by Manganese (Mn)



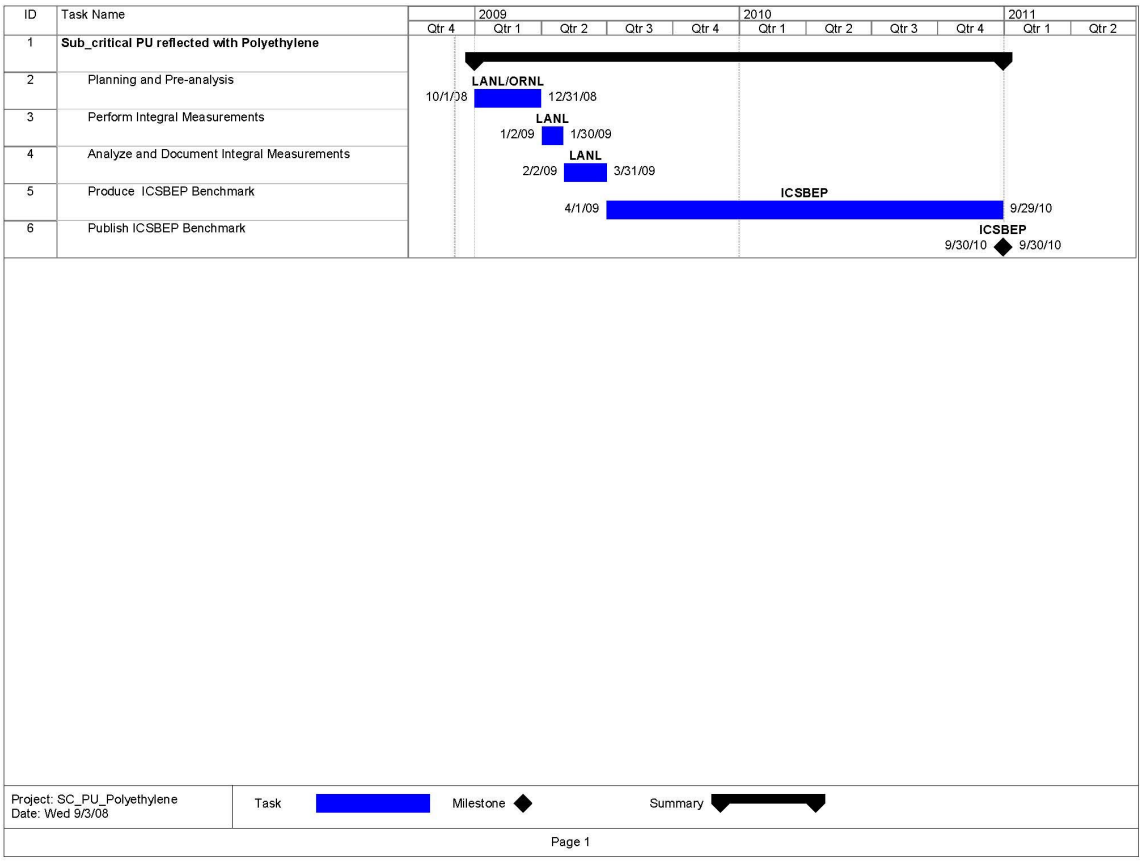
D-3 Integral Measurements – Sub Critical

D-3.5 Plutonium Reflected by Nickel (Ni)



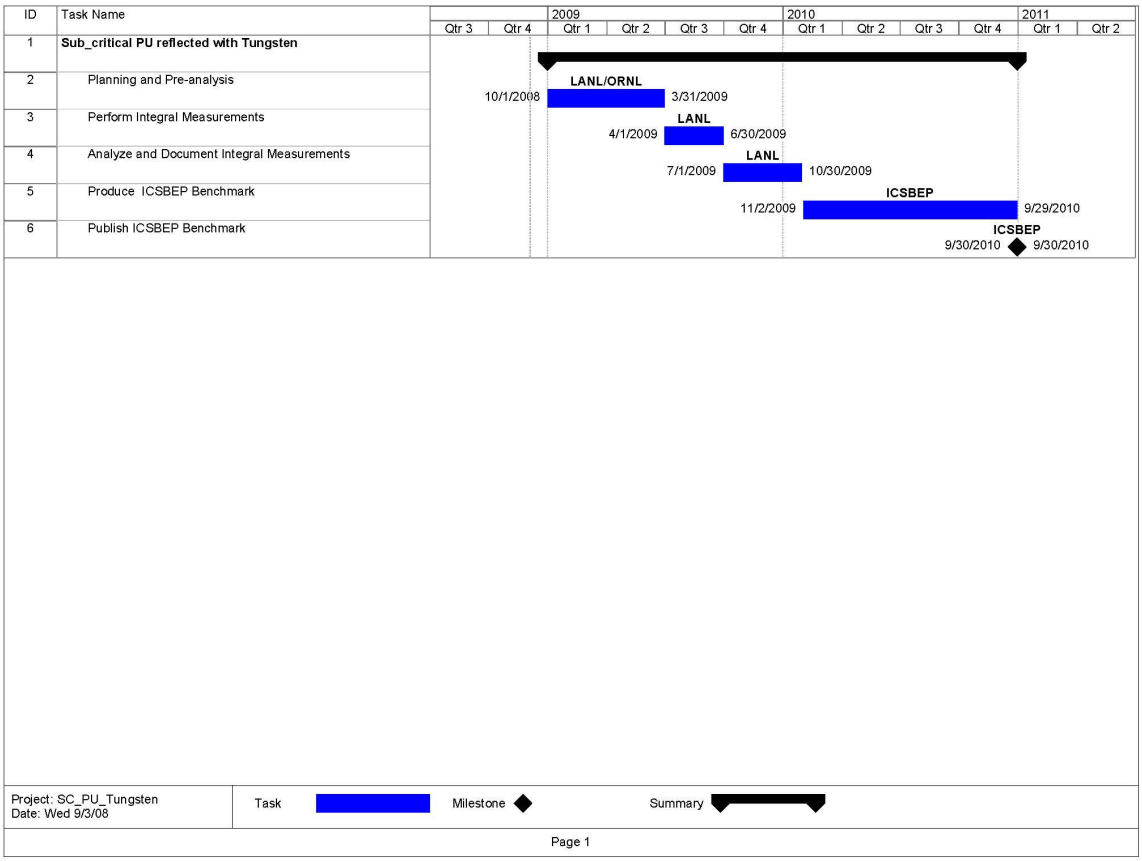
D-3 Integral Measurements – Sub Critical

D-3.6 Plutonium Reflected by Polyethylene



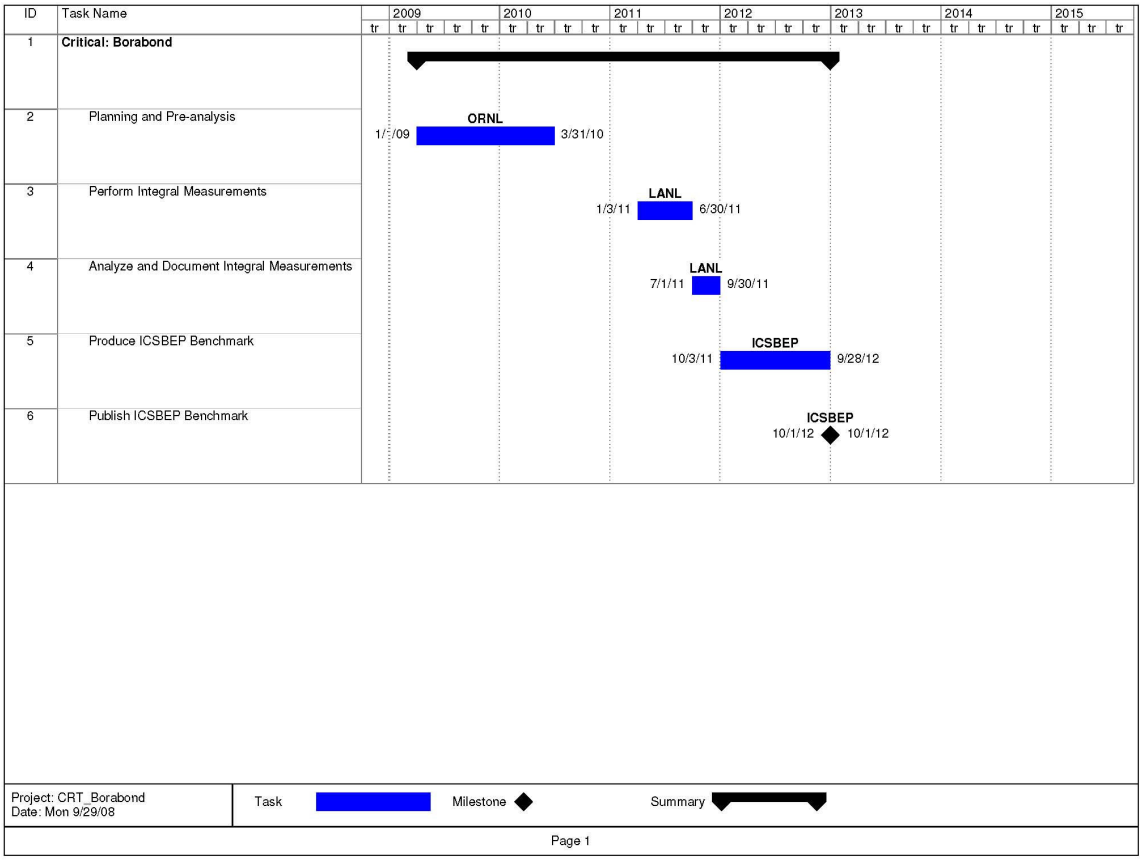
D-3 Integral Measurements – Sub Critical

D-3.7 Plutonium Reflected by Tungsten (W)



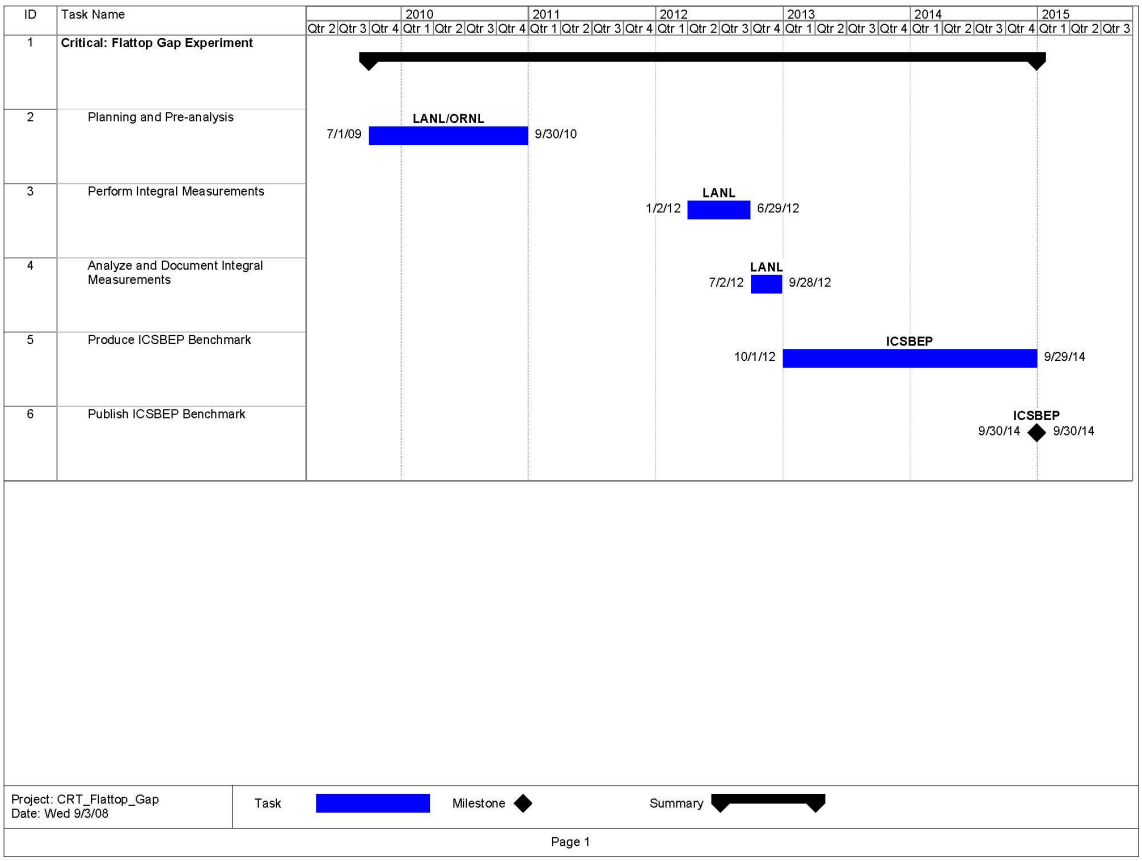
D-4 Integral Measurements – Critical

D-4.1 Borabond



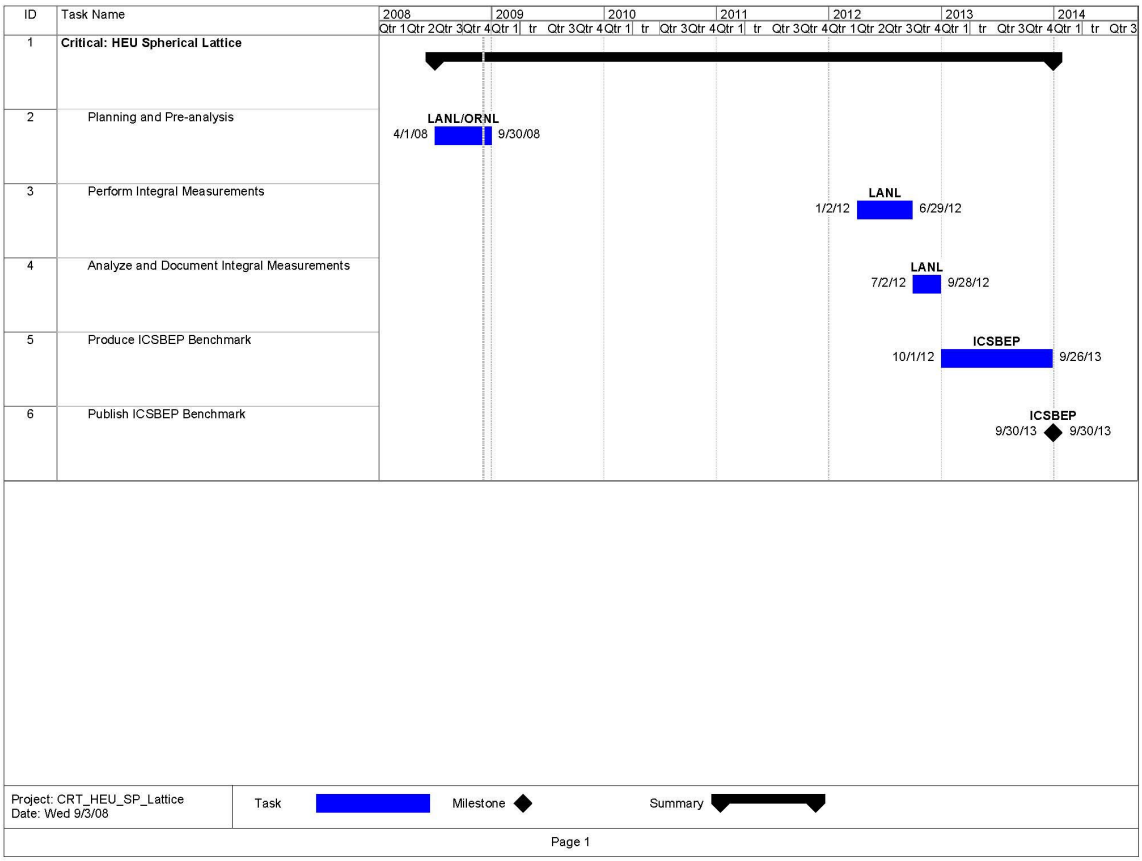
D-4 Integral Measurements – Critical

D-4.2 Flattop Gap Experiment



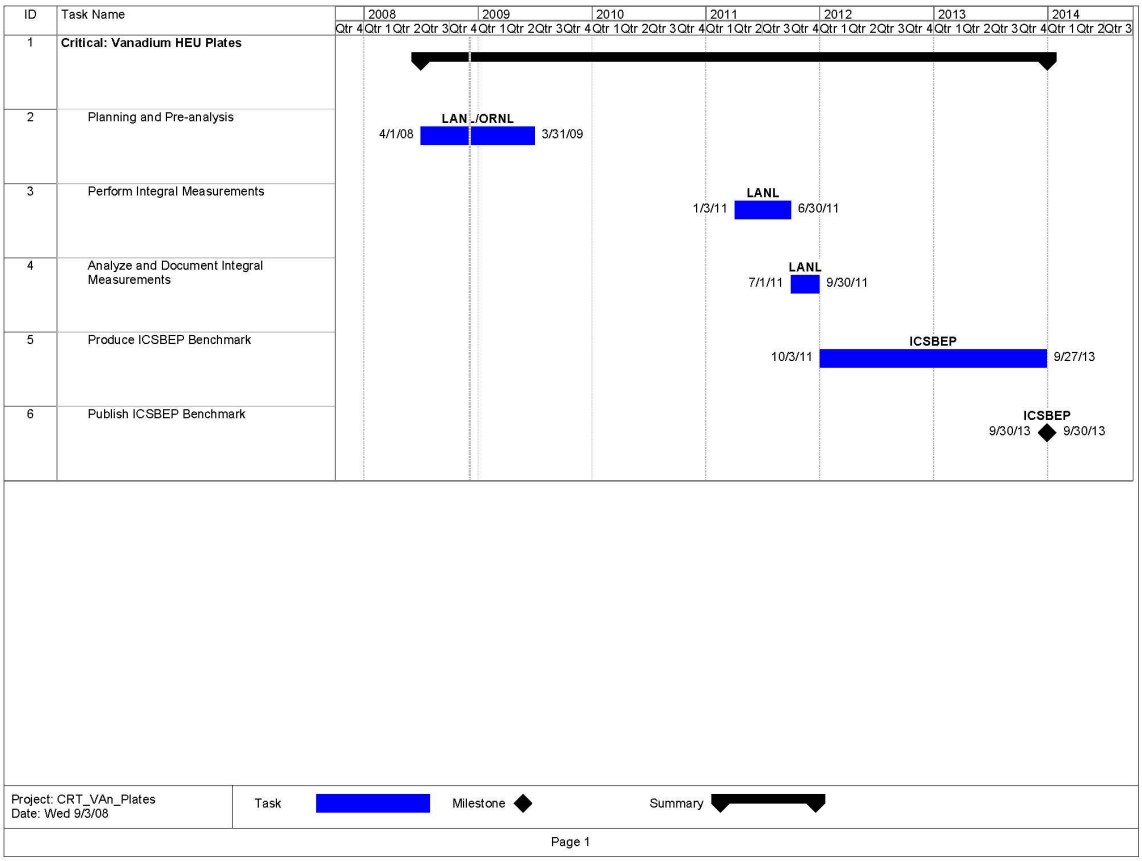
D-4 Integral Measurements – Critical

D-4.3 HEU Spherical Lattice



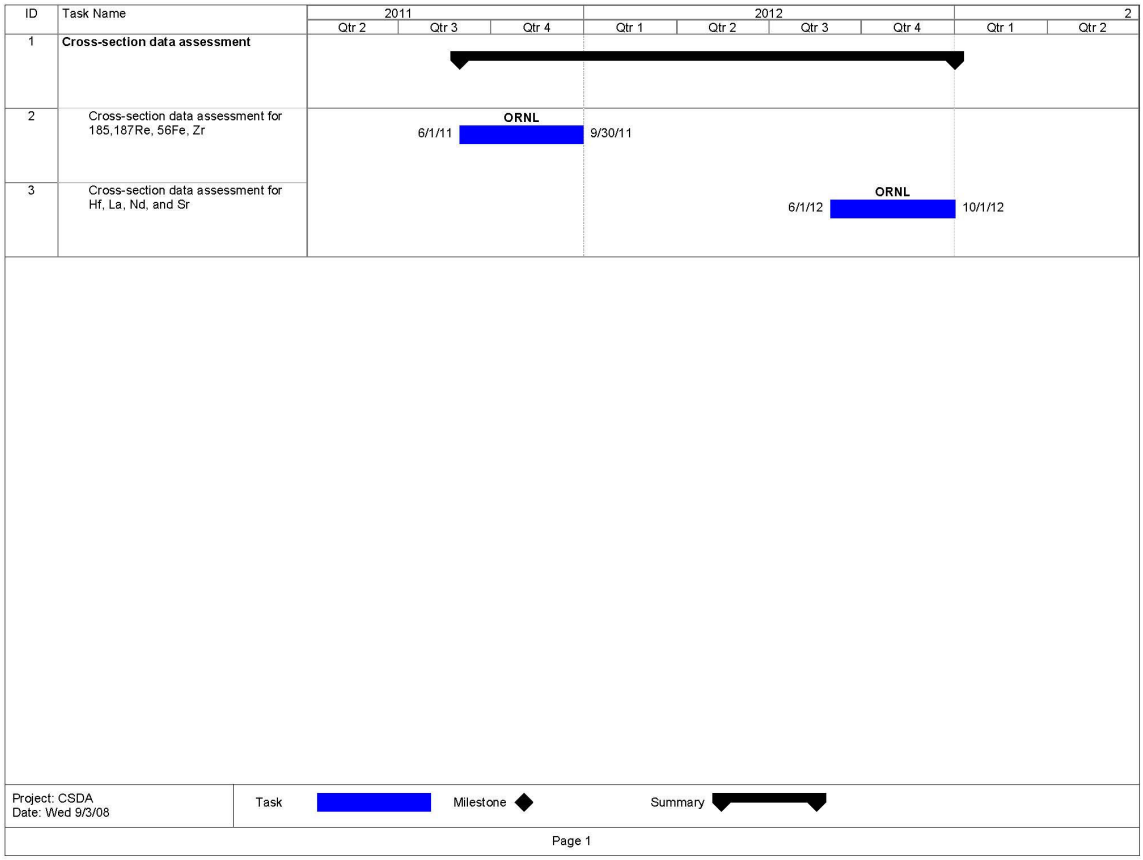
D-4 Integral Measurements – Critical

D-4.4 Vanadium HEU Plates



D-5 Cross-Section Data Assessments (all in one chart)

Rhenium (Re-185, 187), Iron (Fe-56), Zirconium (Zr), Hafnium (Hf), Lanthanum (La), Neodymium (Nd), Strontium (Sr)



Appendix E
FY 2009 Projected Foreign Travel

Meeting or Conference	Date	Organization	No. of Travelers	One Sentence Justification
OECD Expert Group on Uncertainty Methods	December 2008	ANL	1	AM: Participate in expert group (McKnight)
IAEA Technical Meeting on Burnup Credit	April 2009	ANL	1	AM: Participate and present paper on ANL methods as applied to burnup credit (McKnight)
Programmatic Visit to IRSN/CEA (France)	November or December 2008	INL	1	Continuing collaboration on structural material experiments (Briggs)
Programmatic Visit to RA-6 Reactor (Argentina)	February 2009	INL	2	Facilitate evaluation of the RA-6 reactor fueled with silicide fuel (Briggs)
Programmatic Visit to Ljubljana, Slovenia	June 2009	INL	1	Arrange 2010 ICSBEP meeting (Briggs)
Operator training at CEA Valduc, France	Two trips in 2009	LANL	2	Participate in CEF operator training (Clement)
Participate in solution critical experiment design team at CEA Valduc, France	One trip in 2009	LANL	1	Member of Dr. McKamy's team (Clement)
Attend meetings with CEA, Valduc management to discuss future work, training, and collaborations	One trip in 2009	LANL	1	Necessary to continue collaboration (Clement)

OECD Workshop on cross-section processing capabilities	November 2008	ORNL	1	ND: Participate in Workshop on cross-section processing capabilities (Dunn)
OECD Expert Group on Uncertainty Methods	December 2008	ORNL	1	AM: Participate in expert group and present TSUNAMI analyses (Parks)
Meeting with Argentina Atomic Energy Commission	March 2009 Could be earlier	ORNL	2	ND: Discuss collaborations relative to thermal scattering experiments and evaluations (Parks)
IRMM Geel Facility	December 2008 and March 2009	ORNL	2	ND: Discuss process for measurement collaborations in outyears (Parks)
IRMM or IAEA	March 2009	ORNL	1	ND: Collaborations on full-range tungsten evaluations with EU and IAEA (Parks)
Meeting with DICE Developers	April 2009	ORNL	1	AM: Discuss integration of VIBE with DICE (Parks)
IAEA Technical Meeting on Burnup Credit	April 2009	ORNL	1	AM: Participate and present paper on ORNL methods as applied to burnup credit (Parks)
OECD Working Party on Nuclear Criticality Safety	September 2009	ORNL	2	AM: Participate in Working Party and Expert Groups (Parks)